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Design a supply chain model for Baghdad Soft Drinks Company

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Abstract:

In this paper, a mathematical model was built for the supply chain to reduce production, inventory, and transportation in Baghdad Company for Soft Drink. The linear programming method was used to solve this mathematical model. We reduced the cost of production by reduced the daily work hours, the company do not need the overtime hours to work at the same levels of production, and the costs of storage in the company's warehouses and agents' stores have been reduced by making use of the stock correctly, which guarantees reducing costs and preserving products from damage. The units transferred from the company were equal to the units demanded by the agents. The company's mathematical model also achieved profits by (84,663,769) by reducing the total costs to (825,843,231), while the total cost in the company was (910,507,000).

Paper type: ***Research paper*.**

Keywords: linear programming, supply chain, deterministic inventory.

Research is drawn from a thesis not yet discussed.

1- Introduction;

Most companies and production establishments seek to reduce costs and increase profits. The process of cost reduction reduces the costs of the supply chain (production, inventory, transportation). Baghdad Company for Soft Drinks is one of the companies suffering from supply chain costs; a mathematical model has been built that reduces the supply chain costs for this company. Linear programming was used to solve this model and arrive at an optimal solution in which the costs of the supply chain as low as possible and ensure the same required level of production and the same quality.

Fatima Selen's (2021) design of a transmission network, which is an integral part of the supply chain, and it dealt with a two-stage chain containing (distribution centers, transportation costs from the factory to distribution centers and from distribution centers to customers) aiming to reduce the total cost.

Xiaodan Wu et al. In (2019) designing a network for medicine distribution consisting of three levels (medicine manufacturing companies, inventory, hospitals, and health centers) at the lowest costs while taking into account perishable medicine in the storage process.

Pires and Frazzon (2016) studied non-hierarchical supply chain planning while maintaining the individuality of each actor. Linear programming is the predominant approach to modeling and evaluating methods for solving linear programming problems and dealing with types of decision models associated with supply chains.

2- Methods and procedure:

2-1 supply chains;

The field of supply chain management SCM emerged more than half a century ago and continued to evolve in the early 80s, as scholars began to link it to "systems theory" or "holism." In the 90s, research on the supply chain increased dramatically; however, the definitions of the supply chain or supply chain management are not universally shared, as different scholars offer different perspectives as the supply chain relates to coordinating all activities, from raw materials to customer satisfaction. Shaping the supply chain to maximize the operator's competitive advantage over others, we find business people facing many challenges, including (cost, taxes, availability of materials, etc.). (Young, 2016) wrote about continually redesign and reconfigure their supply chains. Due to the shift of the supply chain to globalization, the complexities of supply chain management have increased, so it has become imperative to use mathematical models to improve the functioning of the supply chain. Mathematical models used in solving supply chain problems include linear to integer / mixed number programming, nonlinear programming, multi-objective programming, fuzzy programming, stochastic programming, inference algorithms, hybrid models, and linear programming, which are the focus of our study in this paper. (Yui-Yip, 2019).

It is possible to formulate a mathematical model for the supply chain using linear programming as follows: (Taha, 2017)

Min w $=\sum_{i=1}^{d}\sum_{k=1}^{f}\sum_{t=1}^{g} b_{ikt}Y_{ikt} + \sum_{i=1}^{d}\sum_{k=1}^{f}\sum_{s=1}^{h}\sum_{t=1}^{g} C_{ikst}Z_{ikst} + \sum_{i=1}^{d}\sum_{t=1}^{g} P_{it}X_{it} + \sum_{i=1}^{d}\sum_{t=1}^{g} P_{it}O_{it} + \sum_{i=1}^{d}\sum_{t=1}^{g} IdC_{it}hdc_{it} + \sum_{i=1}^{d}\sum_{k=1}^{f}\sum_{t=1}^{g} Ir_{ikt}hr_{ikt}$
(1)

subject to :

$Idc_{it} = Idc_{i(t-1)} + X_{ijt} - \sum_{k=1}^{f} Y_{ikt} \quad \forall i,j,t \quad (2)$

$Ir_{ikt} = Ir_{ik(t-1)} + Y_{ikt} - \sum_{s=1}^{h} Z_{ikst} \quad \forall i,k,t \quad (3)$

$X_{it} \leq p\ cap_{it} \quad \forall i,t \quad (4)$

$O_{it} \leq p\ cap_{it} \quad \forall i,t \quad (5)$

$\sum_{k=1}^{f} Idc_{ikt} \leq dcap_{it} \quad \forall i,t \quad (6)$

$\sum_{s=1}^{h} Ir_{ikst} \leq rcap_{ikt} \quad \forall i,k,t \quad (7)$

$d_{ikst} - Z_{ikst} = 0 \quad \forall i,k,s,t \quad (8)$

$X_{it}, O_{it}, Y_{ikt}, Z_{ikst}, Idc_{it}, Ir_{ikt} \geq 0 \quad (9)$

Definition of decision variables:

X_{ijt} **: Number of units produced in the standard time of product *i* during the period *t*.**

O_{ijt} **: Number of units produced in the overtime of product *i* during the period *t*.**

Y_{ikt}**: Number of units transferred from product *i* from the company's warehouse to agent *K* in the period *t*.**

z_{ikst} **: Number of units of product *i* transported from retailer *k* to consumer *s* in time *t*.**

Idc_{it} **: Number of units of product *i* in period *t*.**

Irc_{ikt} **: Number of units of product *i* stocked at retailer *k* in period *t*.**

d_{ikst} **: The demanded quantity of product *i* by retailer S from agent *K* during the period *t*.**

Objective Function Coefficients:

P_{it} **: The cost of transporting one unit of product *i* from the factory to the retailer *k* in the period *t*.**

k_{ikt} **: The cost of transporting one unit from the retailer *k* to the consumer *s* in the period *t*.**

C_{ikst} **: The cost of transporting one unit from the retailer *k* to the consumer *s* in the period *t*.**

hdC_{it}**: The cost of storing one unit of product *i* for the period *t*.**

hr_{ikt}**: The cost of storing one unit of product *i* at the retailer *k* for the period *t*.**

$pcap_{it}$**: The maximum power available to produce the product *i* with the period *t*.**

$dcap_{it}$**: The maximum power available to store the product *i* for the period *t*.**

$rcap_{ikt}$**: The maximum power available to store product *i* at the retailer *k* for the period *t*.**

C_{ikst} **: The quantity of demand for the product *i* by the consumer *s* from the retailer *k* in the time period *t*.**

3-Data

The data was obtained from Baghdad Soft Drinks Company, and it was for two families. The size of the first family was (250 ml) and the size of the second family was (750 ml). Each family has three products (Pepsi, Seven, Mirenda). This data was from 2019.

3-1 production:

Each family has a specific number of production lines, as each line produces a specific quantity of product during a certain period where the production of the (250 ml) family was (1,980,000) per month, while the (750 ml) family production was (1,870,000) per month. Accordingly, the maximum production capacity of the (250 ml) family for three products was (77,000), and the (750 ml) family for three products was (73,000) in standard time. As for the maximum production capacity in overtime work, it is about 45% of the quantity produced in the expected time. The production quantity of the (250 ml) family for three products (Pepsi, Seven, Miranda) was (34650), and the three products of the (750 ml) family were (32850).As for the production costs in the standard time, which include (the cost of raw materials, the cost of basic materials, workers' salaries, gas, cans, cartons, gum, and chemicals) for the 250ml family is (4250) while the second family is (3000). The production costs for the first family products in overtime are (4375), and the second family products are (3125).

3-2 The Cost of Inventory:

The cost of inventory includes (workers' salaries, fuel, building maintenance, electricity, and others) divided by the number of products stored in the company to obtain the cost of storing one package per month, so the cost of the two family products was (40) dinar per month for one package, as for the cost of storage for the three agents who have studied the quantity of their order from the company and the cost of transporting products from the two families to them and the cost of storing products in their warehouses on behalf of the first agent (Al-Musayyib) is 67 dinars. The second agent (al-saydea) is 55, and the third agent (Babel) is 90.

3-3 Transportation Cost:

It includes two types of costs and depends on the distance (distance) between distribution centers and the parent company and between distribution centers and retailers.

Al-Musayyib, the cost of transporting the first family (56) and the second family (73).

Saydae, the cost of transporting the first family (28) and the second family (36).

Babylon, the cost of transporting the first family (66) and the second family (86).

3-4 Mathematical Model for The Company: -

The mathematical model for the supply chain of the Baghdad Company for Soft Drinks was formulated and dealt with the production costs in the normal time and overtime, as well as for storing the products in the company and at the agents. It also dealt with the costs of transporting the products understudy from the company to the agent and from there to the retailer.

$$\text{Min} = \sum_i^3 \sum_j^3 \sum_k^3 \sum_t^{12} \quad b_{ijkt} y_{ijkt}$$

$\sum_{j=1}^{3}\sum_{t=1}^{12} 56y_{1j1t} + \sum_{j=1}^{3}\sum_{t=1}^{12} 28y_{1j2t} + \sum_{j=1}^{3}\sum_{t=1}^{12} 66y_{1j3t}$

$$\sum_{i}\sum_{j}\sum_{k}\sum_{s}\sum_{t} C_{ijkst} Z_{ijkst}$$

$\sum_{j=1}^{3}\sum_{t=1}^{12} 15Z_{1j11t} + \sum_{j=1}^{3}\sum_{t=1}^{12} 28Z_{1j12t} + \sum_{j=1}^{3}\sum_{k=2}^{3}\sum_{t=1}^{12} 23Z_{1jk1t} + \sum_{j=1}^{3}\sum_{k=2}^{3}\sum_{t=1}^{12} 38Z_{1jk2t}$

$$\sum_{j}\sum_{t} p_{ijt}x_{ijt}$$

$\sum_{j=1}^{3}\sum_{t=1}^{12} 4250X_{1jt}$

$$\sum_{j}\sum_{t} p_{ijt}O_{ijt}$$

$\sum_{j=1}^{3}\sum_{t=1}^{12} 43750_{1jt}$

$$\sum_{j}\sum_{t} Hdc_{ijt}\, Idc_{ijt}$$

$\sum_{j=1}^{3}\sum_{t=1}^{12} 40Idc_{1jt}$

$$\sum_{j}\sum_{K}\sum_{t} Hr_{ijKt}\, Ir_{ijKt}$$

$\sum_{j=1}^{3}\sum_{k=1}^{3}\sum_{t=1}^{12} 67Ir_{1jkt} + \sum_{j=1}^{3}\sum_{k=1}^{3}\sum_{t=1}^{12} 55Ir_{1jkt} + \sum_{j=1}^{3}\sum_{k=1}^{3}\sum_{t=1}^{12} 90Ir_{1jkt}$

3-5 Constraint

Storage restrictions for the (250 ml) family with her three products (Pepsi, Seven, Miranda) from the month (1) to month (12) in the company can be calculated as follows:-

The number of units stored in the company for the current month = the number of stored units in the previous month + the number of units produced - the request of the first agent in the same month - the request of the second, third agent.

The number of stored units of this product for the 12th is extracted in the same way.

$Idc_{ij(t-1)} + X_{ijt} - \sum_{k=1}^{3} y_{ijkt}$ $\qquad \forall\ i, j, t$

$Idc_{ij(t-1)} + X_{ijt} - \sum_{k=1}^{3} y_{ijkt}$ $\qquad \forall\ 1, 1, t$

$Idc_{111} = 2000 + x_{111} - y_{1111} - y_{1121} - y_{1131}$

$Idc_{112} = Idc_{111} + x_{112} - y_{1112} - y_{1122} - y_{1132}$

$Idc_{ijt} = Idc_{ij(t-1)} + X_{ijt} - \sum y_{ijkt}$ $\qquad \forall 1, 2, t$

$Idc_{121} = 3500 + x_{121} - y_{1211} - y_{1221} - y_{1231}$

$Idc_{122} = Idc_{121} + x_{122} - y_{1212} - y_{1222} - y_{1232}$

$.Idc_{ijt} = Idc_{ij(t-1)} + X_{ijt} - \sum y_{ijkt}$ $\qquad \forall 1, 3, t$

$Idc_{131} = 4000 + x_{131} - y_{1311} - y_{1321} - y_{1331}$

$Idc_{132} = Idc_{131} + x_{132} - y_{1312} - y_{1322} - y_{1332}$

Storage restrictions for the second family (750 ml) can be calculated the same way as the first family.

$$Idc_{ijt} = Idc_{ij(t-1)} + X_{ijt} - \sum y_{ijkt} \qquad \forall 2,1,t$$

$Idc_{211} = 1000 + x_{211} - y_{2111} - y_{2121} - y_{2131}$

$Idc_{212} = Idc_{211} + x_{212} - y_{2112} - y_{2122} - y_{2132}$

$$Idc_{ijt} = Idc_{ij(t-1)} + X_{ijt} - \sum y_{ijkt} \qquad \forall 2,2,t$$

$Idc_{221} = 1755 + x_{221} - y_{2211} - y_{2231} - y_{3231}$

$Idc_{222} = Idc_{221} + x_{222} - y_{2212} - y_{2232} - y_{3232}$

$$Idc_{ijt} = Idc_{ij(t-1)} + X_{ijt} - \sum y_{ijkt} \qquad \forall 2,3,t$$

$Idc_{231} = 2000 + x_{231} - y_{2311} - y_{2321} - y_{2331}$

$Idc_{232} = Idc_{231} + x_{232} - y_{2312} - y_{2322} - y_{2332}$

Storage restrictions for the (250 ml) family with her three products (Pepsi, Seven, Miranda) from the month (1) to month (12) in the company can be calculated as follows:-

The number of units stored at the agent for the current month = the number of stored units in the previous month + the Number of units required - The number of units transferred to the first consumer - The number of units transferred to the second consumer.

The number of stored units of this product for the 12th is extracted in the same way.

$$Ir_{ijkt} = Ir_{ijk(t-1)} + y_{ijkt} - \sum z_{ijkst} \qquad \forall i,j,k,t$$

$$Ir_{ijkt} = Ir_{ijk(t-1)} + y_{ijkt} - \sum z_{ijkst} \qquad \forall 1,1,1,t$$

$Ir_{1111} = 120 + y_{1111} - z_{11111} - z_{11121}$

$Ir_{1112} = Ir_{1111} + y_{1112} - z_{11112} - z_{11122}$

$$Ir_{ijkt} = Ir_{ijk(t-1)} + y_{ijkt} - \sum z_{ijkst} \qquad \forall 1,1,2,t$$

$Ir_{1121} = 150 + y_{1121} - z_{11211} - z_{11221}$

$Ir_{1122} = Ir_{1121} + y_{1122} - z_{11212} - z_{11222}$

$$Ir_{ijkt} = Ir_{ijk(t-1)} + y_{ijkt} - \sum z_{ijkst} \qquad \forall 1,1,3,t$$

$Ir_{1131} = 175 + y_{1131} - z_{11311} - z_{11321}$

$Ir_{1132} = Ir_{1131} + y_{1132} - z_{11312} - z_{11322}$

$$Ir_{ijkt} = Ir_{ijk(t-1)} + y_{ijkt} - \sum z_{ijkst} \qquad \forall 1,2,1,t$$

$Ir_{1211} = 150 + y_{1211} - z_{12111} - z_{12121}$

$Ir_{1212} = Ir_{1211} + y_{1212} - z_{12112} - z_{12122}$

$$Ir_{ijkt} = Ir_{ijk(t-1)} + y_{ijkt} - \sum z_{ijkst} \qquad \forall 1,2,2,t$$

$Ir_{1221} = 200 + y_{1221} - z_{12211} - z_{12221}$

$Ir_{1222} = Ir_{1221} + y_{1222} - z_{12212} - z_{12222}$

$$Ir_{ijkt} = Ir_{ijk(t-1)} + y_{ijkt} - \sum z_{ijkst} \qquad \forall 1,2,3,t$$

$Ir_{1231} = 200 + y_{1231} - z_{12311} - z_{12321}$

$Ir_{1232} = Ir_{1231} + y_{1232} - z_{12312} - z_{12322}$

$$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 1,3,1,t$$

$Ir_{1311}=135+y_{1311}-z_{13111}-z_{13121}$

$Ir_{1312}=Ir_{1311}+y_{1312}-z_{13112}-z_{13122}$

$$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 1,3,2,t$$

$Ir_{1321}=155+y_{1321}-z_{13211}-z_{13221}$

$Ir_{1322}=Ir_{1321}+y_{1322}-z_{13212}-z_{13222}$

$$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 1,3,3,t$$

$Ir_{1331}=355+y_{1331}-z_{13311}-z_{13321}$

$Ir_{1332}=Ir_{1331}+y_{1332}-z_{13312}-z_{13322}$

And so for the second family of the three products in the three agents' stores

$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 2,1,1,t$ **(Pepsi)**

First agent

$Ir_{2111}=175+y_{2111}-z_{21111}-z_{21121}$

$Ir_{2112}=Ir_{2111}+y_{2112}-z_{21112}-z_{21122}$

$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 2,1,2,t$ **(Pepsi)**

Second agent

$Ir_{2121}=205+y_{2121}-z_{21211}-z_{21221}$

$Ir_{2122}=Ir_{2121}+y_{2122}-z_{21212}-z_{21222}$

$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 2,1,3,t$ **(Pepsi)**

Third agent

$Ir_{2131}=175+y_{2131}-Z_{21311}-Z_{21321}$

$Ir_{2132}=Ir_{2131}+y_{2132}-Z_{21312}-Z_{21322}$

$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 2,2,1,t$ **(Seven)**

First agent

$Ir_{2211}=185+y_{2211}-z_{22111}-z_{22121}$

$Ir_{2212}=Ir_{2211}+y_{2212}-z_{22112}-z_{22122}$

$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 2,2,2,t$ **(Seven)**

Second agent

$Ir_{2221}=107+y_{2221}-z_{22211}-z_{22221}$

$Ir_{2222}=Ir_{2221}+y_{2222}-z_{22212}-z_{22222}$

$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 2,2,3,t$ **(Seven)**

Third agent

$Ir_{2231}=175+y_{2231}-Z_{22311}-Z_{22321}$

$Ir_{2232}=Ir_{2231}+y_{2232}-Z_{22312}-Z_{22322}$

$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 2,3,1,t$

(Miranda) First agent $Ir_{2311}=200+y_{2311}-z_{23111}-z_{23121}$

$Ir_{2312}=Ir_{2311}+y_{2312}-z_{23112}-z_{23122}$

$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 2,3,2,t$ **(Miranda)**

Second agent

$Ir_{2321}=155+y_{2321}-z_{23211}-z_{23221}$

$Ir_{2322}=Ir_{2321}+y_{2322}-z_{23212}-z_{23222}$

$Ir_{\mathrm{ijkt}} = Ir_{\mathrm{ijk(t-1)}} + y_{\mathrm{ijkt}} - \sum z_{ijkst} \qquad \forall 2,3,3,t$ **(Miranda)**

Second agent

$Ir_{2331}=110+y_{2331}-z_{23311}-z_{23321}$

$Ir_{2332}=Ir_{2331}+y_{2332}-z_{23312}-z_{23322}$

Production restrictions in the standard time should not exceed the maximum storage capacity of the first family (250ml) and her three products (Pepsi, Seven, Miranda) from month (1) to month (12).

$$\sum x_{it} \leq pcap_{it}$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} X_{1jt} \leq 77000$$

Production restrictions in the standard time should not exceed the maximum storage capacity of the second family (750ml) and her three products (Pepsi, Seven, Miranda) from the month (1) to month (12).

$$\sum_{j=1}^{3}\sum_{t=1}^{12} X_{2jt} \leq 73000$$

Production restrictions in the overtime should not exceed the maximum storage capacity of the first family (250ml) and her three products (Pepsi, Seven, Miranda) from the month (1) to month (12).

$$\sum O_{ijk} \leq \text{N cap is t} \quad \forall\, i,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} O_{1jt} \leq 34650$$

Production restrictions in the overtime, Which should not exceed the maximum storage capacity of the second family (750ml) and her three products (Pepsi, Seven, Miranda) from the month (1) to month (12).

$$\sum_{J} O_{ijt} \leq \text{N cap is t} \quad \forall\, i,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} O_{2jt} \leq 34650$$

The number of units of the first family (250ml) should not exceed the maximum storage capacity in the company's stores.

$$\sum_{J} Idc_{ijt} \leq \text{d cap is t} \quad \forall\, i,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} Idc_{1jt} \leq 10857$$

The number of units of the second family (750ml) should not exceed the maximum storage capacity in the company's stores.

$$\sum_{J} Idc_{ijt} \leq \text{d cap is t} \quad \forall\, i,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} Idc_{2jt} \leq 8935$$

The number of units of the first family (250ml) should not exceed the maximum storage capacity in the first agents' stores.

$$\sum_{J} Ir_{ijkt} \leq \text{r cap is t} \quad \forall\, i,k,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} Ir_{1j1t} \leq 3333$$

The number of units from the first family (250ml) should not exceed the maximum storage capacity in the second agents' stores.

$$\sum_{J} Ir_{ijkt} \quad \leq \quad \text{r cap is t} \qquad \forall\, i,k,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} Ir_{1j2t} \ \leq\ 4400$$

The number of units of the first family (250ml) should not exceed the maximum storage capacity in the third agents' stores.

$$\sum_{J} Ir_{ijt} \quad \leq \quad \text{r cap is t} \qquad \forall\, i,k,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} Ir_{1j3t} \quad \leq\ 5000$$

The number of units of the second family (750ml) should not exceed the maximum storage capacity in the first agents' stores.

$$\sum_{J} Ir_{ijt} \quad \leq \quad \text{r cap is t} \qquad \forall\, i,k,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} Ir_{2j1t} \quad \leq \quad 2000$$

The number of units of the second family (750ml) should not exceed the maximum storage capacity in the second agents' stores.

$$\sum_{J} Ir_{ijt} \quad \leq \quad \text{r cap is t} \qquad \forall\, i,k,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} Ir_{2j2t} \ \leq \quad 4000$$

The number of units of the second family (750 ml) should not exceed the maximum storage capacity in the third agents' stores.

$$\sum_{J} Ir_{ijt} \quad \leq \quad \text{r cap is t} \qquad \forall\, i,k,t$$

$$\sum_{j=1}^{3}\sum_{t=1}^{12} Ir_{2j3t} \quad \leq \quad 4500$$

In the last entry, the transferred units are equal to the order, and the order quantity appears in the results tables (1-2), where it denotes (Z) the transferred units to fill the agents ' requests.

$$Z_{ijkst} = D_{ijkst}$$

The mathematical solving model showed the number of units transported from the company to the agent and from the agent to the retailer, as seen in the table (1-2).

4- Discuss the results:

Using the mathematical model, the first table shows the number of inventory units at (the company and agents) where we notice that the inventory became zero in all months of the year and for all the products understudy in the company's stores except for the first month of the year for the ship producers and the Miranda from the first family, where the stock was at the beginning of the year 1420 for ships and 2080 for Miranda. Moreover, zero in all months of the year in the agents' store. The results showed that the company could meet the consumer's need in some months (the beginning of each year) from the existing

inventory for the previous month (the last month of the year) and reduce the production process at the beginning of the new year in order to reduce storage costs and maintain product quality from damage in stores. It also needs a period of maintenance and sterilization of the production lines. The model concluded that there is no need to work overtime, which costs the company large sums of money, and the results showed (zero inventory) in the company and production in the extra time is zero, which is the goal required to reduce the company's costs. The total cost (production, inventory, transport) was 910,507,000, while the total cost by using the mathematical model amounted to 825,843,231, a difference of 84,663,769 profits to the Company. Also, the number of units transferred from the company's inventory to the agents did not exceed the maximum storage capacity in the company, and the units transferred from the agents' stores to the retailers did not exceed the maximum inventory capacity at the agents.

The number of units stored in the company's warehouses for the two families and the three products (Pepsi, Seven, Miranda) is zero, meaning that ($Idcijt = 0$) in all months of the year except for (Idc_{121}) its value was 1420, meaning the first family, the second product, the first month, as well as (Idc_{131}) was valued at 2085 and meant first family, third product, first month. Whereas the inventory results in the three agents' stores ($Ir_{ijt} = 0$) in all months of the year.

Production in overtime ($O_{ijt} = 0$) for all months of the year. The results showed that production in the standard time meets the market need, as the number of units produced was sufficient to meet the consumer's demand. The results also showed that the production of the first family of the second product in the first month of the year = zero due to the presence of stocks from the previous year sufficient to meet the demand, as well as the case in production. The first family of Miranda in the same month, where the storage was sufficient to meet the demand, and therefore production = zero. As for the quantities of products in the standard time for all products under study and the rest of the year, they were in Table (1).

Table (1) Production in standard time

Production in standard time	decision variables	Production in standard time	decision variables	Production in standard time	decision variables
0	X_{131}	0	X_{121}	93	X_{111}
615	X_{132}	1325	X_{122}	2625	X_{112}
2920	X_{133}	3115	X_{123}	2750	X_{113}
3164	X_{134}	3400	X_{124}	3200	X_{114}
3467	X_{135}	4015	X_{125}	3690	X_{115}
3972	X_{136}	4400	X_{126}	4490	X_{116}
4350	X_{137}	4770	X_{127}	5115	X_{117}
4209	X_{138}	4738	X_{128}	5090	X_{118}
3485	X_{139}	3985	X_{129}	4420	X_{119}
3140	X_{1310}	3300	X_{1210}	3880	X_{1110}
2795	X_{1311}	2840	X_{1211}	3360	X_{1111}
2670	X_{1312}	2645	X_{1212}	2655	X_{1112}
170	X_{231}	453	X_{221}	990	X_{211}
2760	X_{232}	2880	X_{222}	2754	X_{212}

3025	X_{233}	3200	X_{223}	3130	X_{213}
3510	X_{234}	3648	X_{224}	3568	X_{214}
4055	X_{235}	3974	X_{225}	4217	X_{215}
3880	X_{236}	4092	X_{226}	4440	X_{216}
3424	X_{237}	3515	X_{227}	3967	X_{217}
2947	X_{238}	3077	X_{228}	3310	X_{218}
2586	X_{239}	2638	X_{229}	2960	X_{219}
2505	X_{2310}	2574	X_{2210}	2720	X_{2110}
2410	X_{2311}	2415	X_{2211}	2598	X_{2111}
2512	X_{2312}	2445	X_{2212}	2525	X_{2112}

As for the number of units transferred from the company to the agent, it was equal to the demand for it, as well as the units transferred from the agent to the retailers, as the quantities required in the first and last months of the year were less than the demand in the rest of the month of the year, meaning that the demand increased in the summer months than in the rest of the months And as shown in Table (2):-

Table (2) Units transferred from the company to the agent and from there to the retailer

agent to retailer	decision variables	agent to retailer	decision variables	the company to the agent	decision variables
400	Z_{21111}	400	Z_{11111}	705	Y_{1111}
440	Z_{21112}	410	Z_{11112}	860	Y_{1112}
550	Z_{21113}	430	Z_{11113}	880	Y_{1113}
580	Z_{21114}	500	Z_{11114}	1040	Y_{1114}
670	Z_{21115}	520	Z_{11115}	1190	Y_{1115}
760	Z_{21116}	660	Z_{11116}	1440	Y_{1116}
800	Z_{21117}	800	Z_{11117}	1650	Y_{1117}
650	Z_{21118}	870	Z_{11118}	1720	Y_{1118}
570	Z_{21119}	820	Z_{11119}	1590	Y_{1119}
520	Z_{211110}	700	Z_{111110}	1320	Y_{11110}
500	Z_{211111}	550	Z_{111111}	1090	Y_{11111}
410	Z_{211112}	420	Z_{111112}	820	Y_{11112}
440	Z_{21121}	425	Z_{11121}	680	Y_{1121}
455	Z_{21122}	450	Z_{11122}	840	Y_{1122}
480	Z_{21123}	450	Z_{11123}	870	Y_{1123}
505	Z_{21124}	540	Z_{11124}	1020	Y_{1124}
660	Z_{21125}	670	Z_{11125}	1180	Y_{1125}
730	Z_{21126}	780	Z_{11126}	1460	Y_{1126}
790	Z_{21127}	850	Z_{11127}	1725	Y_{1127}
640	Z_{21128}	850	Z_{11128}	1740	Y_{1128}
590	Z_{21129}	770	Z_{11129}	1430	Y_{1129}
525	Z_{211210}	620	Z_{111210}	1330	Y_{11210}
430	Z_{211211}	540	Z_{111211}	1180	Y_{11211}
420	Z_{211212}	400	Z_{111212}	925	Y_{11212}
425	Z_{21211}	400	Z_{11211}	708	Y_{1131}
465	Z_{21212}	410	Z_{11212}	925	Y_{1132}
500	Z_{21213}	415	Z_{11213}	1000	Y_{1133}
600	Z_{21214}	460	Z_{11214}	1140	Y_{1134}
752	Z_{21215}	580	Z_{11215}	1320	Y_{1135}

760	Z_{21216}	700	Z_{11216}	1590	Y_{1136}
610	Z_{21217}	850	Z_{11217}	1740	Y_{1137}
515	Z_{21218}	850	Z_{11218}	1630	Y_{1138}
445	Z_{21219}	730	Z_{11219}	1400	Y_{1139}
400	Z_{212110}	680	Z_{112110}	1230	Y_{11310}
423	Z_{212111}	600	Z_{112111}	1090	Y_{11311}
430	Z_{212112}	450	Z_{112112}	910	Y_{11312}
430	Z_{21221}	430	Z_{11221}	730	Y_{1211}
444	Z_{21222}	430	Z_{11222}	920	Y_{1212}
510	Z_{21223}	455	Z_{11223}	1070	Y_{1213}
660	Z_{21224}	560	Z_{11224}	1130	Y_{1214}
720	Z_{21225}	600	Z_{11225}	1350	Y_{1215}
740	Z_{21226}	760	Z_{11226}	1630	Y_{1216}
605	Z_{21227}	875	Z_{11227}	1710	Y_{1217}
530	Z_{21228}	890	Z_{11228}	1580	Y_{1218}
450	Z_{21229}	700	Z_{11229}	1400	Y_{1219}
450	Z_{212210}	650	Z_{112210}	1150	Y_{12110}
415	Z_{212211}	580	Z_{112211}	970	Y_{12111}
415	Z_{212212}	475	Z_{112212}	910	Y_{12112}
430	Z_{21311}	450	Z_{11311}	690	Y_{1221}
480	Z_{21312}	450	Z_{11312}	905	Y_{1222}
550	Z_{21313}	480	Z_{11313}	1035	Y_{1223}
590	Z_{21314}	560	Z_{11314}	1200	Y_{1224}
685	Z_{21315}	610	Z_{11315}	1485	Y_{1225}
750	Z_{21316}	770	Z_{11316}	1520	Y_{1226}
532	Z_{21317}	860	Z_{11317}	1610	Y_{1227}
440	Z_{21318}	870	Z_{11318}	1660	Y_{1228}
455	Z_{21319}	740	Z_{11319}	1385	Y_{1229}
400	Z_{213110}	700	Z_{113110}	1120	Y_{12210}
430	Z_{213111}	640	Z_{113111}	900	Y_{12211}
420	Z_{213112}	500	Z_{113112}	860	Y_{12212}
420	Z_{21321}	433	Z_{11321}	660	Y_{1231}
470	Z_{21322}	475	Z_{11322}	920	Y_{1232}
540	Z_{21323}	520	Z_{11323}	1010	Y_{1233}
633	Z_{21324}	580	Z_{11324}	1070	Y_{1234}
730	Z_{21325}	710	Z_{11325}	1180	Y_{1235}
700	Z_{21326}	820	Z_{11326}	1250	Y_{1236}
630	Z_{21327}	880	Z_{11327}	1450	Y_{1237}
535	Z_{21328}	760	Z_{11328}	1498	Y_{1238}
450	Z_{21329}	660	Z_{11329}	1200	Y_{1239}
425	Z_{213210}	530	Z_{113210}	1030	Y_{12310}
400	Z_{213211}	450	Z_{113211}	970	Y_{12311}
430	Z_{213212}	410	Z_{113212}	875	Y_{12312}
450	Z_{22111}	430	Z_{12111}	715	Y_{1311}
470	Z_{22112}	470	Z_{12112}	870	Y_{1312}
550	Z_{22113}	510	Z_{12113}	910	Y_{1313}
633	Z_{22114}	550	Z_{12114}	980	Y_{1314}
640	Z_{22115}	680	Z_{12115}	1000	Y_{1315}
730	Z_{22116}	790	Z_{12116}	1150	Y_{1316}
680	Z_{22117}	850	Z_{12117}	1340	Y_{1317}

520	Z_{22118}	750	Z_{12118}	1360	Y_{1318}
435	Z_{22119}	700	Z_{12119}	1125	Y_{1319}
444	Z_{221110}	600	Z_{121110}	1030	Y_{13110}
390	Z_{221111}	500	Z_{121111}	905	Y_{13111}
420	Z_{221112}	440	Z_{121112}	895	Y_{13112}
450	Z_{22121}	450	Z_{12121}	705	Y_{1321}
580	Z_{22122}	450	Z_{12122}	930	Y_{1322}
500	Z_{22123}	560	Z_{12123}	1000	Y_{1323}
620	Z_{22124}	580	Z_{12124}	1100	Y_{1324}
650	Z_{22125}	670	Z_{12125}	1140	Y_{1325}
680	Z_{22126}	840	Z_{12126}	1302	Y_{1326}
570	Z_{22127}	860	Z_{12127}	1460	Y_{1327}
500	Z_{22128}	830	Z_{12128}	1610	Y_{1328}
430	Z_{22129}	700	Z_{12129}	1275	Y_{1329}
415	Z_{221210}	550	Z_{121210}	1140	Y_{13210}
410	Z_{221211}	470	Z_{121211}	1015	Y_{13211}
410	Z_{221212}	470	Z_{121212}	945	Y_{13212}
425	Z_{22211}	440	Z_{12211}	495	Y_{1331}
435	Z_{22212}	440	Z_{12212}	900	Y_{1332}
525	Z_{22213}	505	Z_{12213}	1010	Y_{1333}
600	Z_{22214}	650	Z_{12214}	1084	Y_{1334}
642	Z_{22215}	875	Z_{12215}	1327	Y_{1335}
630	Z_{22216}	860	Z_{12216}	1520	Y_{1336}
570	Z_{22217}	810	Z_{12217}	1550	Y_{1337}
517	Z_{22218}	810	Z_{12218}	1239	Y_{1338}
460	Z_{22219}	665	Z_{12219}	1085	Y_{1339}
415	Z_{222110}	510	Z_{122110}	970	Y_{13310}
400	Z_{222111}	400	Z_{122111}	875	Y_{13311}
400	Z_{222112}	430	Z_{122112}	830	Y_{13312}
525	Z_{22221}	450	Z_{12221}	665	Y_{2111}
530	Z_{22222}	465	Z_{12222}	895	Y_{2112}
585	Z_{22223}	530	Z_{12223}	1030	Y_{2113}
610	Z_{22224}	550	Z_{12224}	1085	Y_{2114}
650	Z_{22225}	610	Z_{12225}	1330	Y_{2115}
675	Z_{22226}	660	Z_{12226}	1490	Y_{2116}
500	Z_{22227}	800	Z_{12227}	1590	Y_{2117}
485	Z_{22228}	850	Z_{12228}	1290	Y_{2118}
460	Z_{22229}	720	Z_{12229}	1160	Y_{2119}
415	Z_{222210}	610	Z_{122210}	1045	Y_{21110}
405	Z_{222211}	500	Z_{122211}	930	Y_{21111}
400	Z_{222212}	430	Z_{122212}	830	Y_{21112}
400	Z_{22311}	420	Z_{12311}	650	Y_{2121}
420	Z_{22312}	455	Z_{12312}	909	Y_{2122}
540	Z_{22313}	530	Z_{12313}	1010	Y_{2123}
660	Z_{22314}	550	Z_{12314}	1260	Y_{2124}
732	Z_{22315}	610	Z_{12315}	1472	Y_{2125}
712	Z_{22316}	675	Z_{12316}	1500	Y_{2126}
615	Z_{22317}	800	Z_{12317}	1215	Y_{2127}
545	Z_{22318}	818	Z_{12318}	1045	Y_{2128}
440	Z_{22319}	700	Z_{12319}	895	Y_{2129}

435	Z_{223110}	580	Z_{123110}	850	Y_{21210}
410	Z_{223111}	530	Z_{123111}	838	Y_{21211}
410	Z_{223112}	475	Z_{123112}	845	Y_{21212}
425	Z_{22321}	440	Z_{12321}	675	Y_{2131}
445	Z_{22322}	465	Z_{12322}	950	Y_{2132}
500	Z_{22323}	480	Z_{12323}	1090	Y_{2133}
525	Z_{22324}	520	Z_{12324}	1223	Y_{2134}
660	Z_{22325}	570	Z_{12325}	1415	Y_{2135}
665	Z_{22326}	575	Z_{12326}	1450	Y_{2136}
580	Z_{22327}	650	Z_{12327}	1162	Y_{2137}
510	Z_{22328}	680	Z_{12328}	975	Y_{2138}
413	Z_{22329}	500	Z_{12329}	905	Y_{2139}
450	Z_{223210}	450	Z_{123210}	825	Y_{21310}
400	Z_{223211}	440	Z_{123211}	830	Y_{21311}
405	Z_{223212}	400	Z_{123212}	850	Y_{21312}
440	Z_{23111}	430	Z_{13111}	715	Y_{2211}
460	Z_{23112}	445	Z_{13112}	1050	Y_{2212}
430	Z_{23113}	460	Z_{13113}	1050	Y_{2213}
530	Z_{23114}	510	Z_{13114}	1253	Y_{2214}
675	Z_{23115}	525	Z_{13115}	1290	Y_{2215}
700	Z_{23116}	600	Z_{13116}	1410	Y_{2216}
600	Z_{23117}	660	Z_{13117}	1250	Y_{2217}
525	Z_{23118}	660	Z_{13118}	1020	Y_{2218}
440	Z_{23119}	500	Z_{13119}	865	Y_{2219}
465	Z_{231110}	480	Z_{131110}	859	Y_{22110}
380	Z_{231111}	435	Z_{131111}	800	Y_{22111}
420	Z_{231112}	420	Z_{131112}	830	Y_{22112}
425	Z_{23121}	420	Z_{13121}	843	Y_{2221}
460	Z_{23122}	425	Z_{13122}	965	Y_{2222}
520	Z_{23123}	450	Z_{13123}	1110	Y_{2223}
550	Z_{23124}	470	Z_{13124}	1210	Y_{2224}
680	Z_{23125}	475	Z_{13125}	1292	Y_{2225}
715	Z_{23126}	550	Z_{13126}	1305	Y_{2226}
562	Z_{23127}	680	Z_{13127}	1070	Y_{2227}
500	Z_{23128}	700	Z_{13128}	1002	Y_{2228}
456	Z_{23129}	625	Z_{13129}	920	Y_{2229}
420	Z_{231210}	550	Z_{131210}	830	Y_{22210}
400	Z_{231211}	470	Z_{131211}	805	Y_{22211}
400	Z_{231212}	475	Z_{131212}	800	Y_{22212}
415	Z_{23211}	430	Z_{13211}	650	Y_{2231}
450	Z_{23212}	480	Z_{13212}	865	Y_{2232}
455	Z_{23213}	520	Z_{13213}	1040	Y_{2233}
575	Z_{23214}	560	Z_{13214}	1185	Y_{2234}
615	Z_{23215}	600	Z_{13215}	1392	Y_{2235}
650	Z_{23216}	640	Z_{13216}	1377	Y_{2236}
600	Z_{23217}	720	Z_{13217}	1195	Y_{2237}
512	Z_{23218}	800	Z_{13218}	1055	Y_{2238}
425	Z_{23219}	650	Z_{13219}	853	Y_{2239}
410	Z_{232110}	580	Z_{132110}	885	Y_{22310}
395	Z_{232111}	540	Z_{132111}	810	Y_{22311}

430	Z_{232112}	515	Z_{132112}	815	Y_{22312}
455	Z_{23221}	430	Z_{13221}	665	Y_{2311}
430	Z_{23222}	450	Z_{13222}	920	Y_{2312}
500	Z_{23223}	480	Z_{13223}	950	Y_{2313}
540	Z_{23224}	540	Z_{13224}	1080	Y_{2314}
635	Z_{23225}	540	Z_{13225}	1355	Y_{2315}
670	Z_{23226}	662	Z_{13226}	1415	Y_{2316}
612	Z_{23227}	740	Z_{13227}	1162	Y_{2317}
525	Z_{23228}	810	Z_{13228}	1025	Y_{2318}
440	Z_{23229}	625	Z_{13229}	896	Y_{2319}
400	Z_{232210}	560	Z_{132210}	885	Y_{23110}
410	Z_{232211}	475	Z_{132211}	780	Y_{23111}
412	Z_{232212}	430	Z_{132212}	820	Y_{23112}
435	Z_{23311}	415	Z_{13311}	715	Y_{2321}
450	Z_{23312}	440	Z_{13312}	880	Y_{2322}
540	Z_{23313}	510	Z_{13313}	955	Y_{2323}
665	Z_{23314}	524	Z_{13314}	1115	Y_{2324}
630	Z_{23315}	677	Z_{13315}	1250	Y_{2325}
595	Z_{23316}	750	Z_{13316}	1320	Y_{2326}
500	Z_{23317}	750	Z_{13317}	1212	Y_{2327}
460	Z_{23318}	579	Z_{13318}	1037	Y_{2328}
425	Z_{23319}	510	Z_{13319}	865	Y_{2329}
380	Z_{233110}	440	Z_{133110}	810	Y_{23210}
385	Z_{233111}	425	Z_{133111}	805	Y_{23211}
440	Z_{233112}	430	Z_{133112}	842	Y_{23212}
465	Z_{23321}	435	Z_{13321}	790	Y_{2331}
510	Z_{23322}	460	Z_{13322}	960	Y_{2332}
580	Z_{23323}	500	Z_{13323}	1120	Y_{2333}
650	Z_{23324}	560	Z_{13324}	1315	Y_{2334}
820	Z_{23325}	650	Z_{13325}	1450	Y_{2335}
550	Z_{23326}	770	Z_{13326}	1145	Y_{2336}
550	Z_{23327}	800	Z_{13327}	1050	Y_{2337}
425	Z_{23328}	660	Z_{13328}	885	Y_{2338}
400	Z_{23329}	575	Z_{13329}	825	Y_{2339}
430	Z_{233210}	530	Z_{133210}	810	Y_{23310}
440	Z_{233211}	450	Z_{133211}	825	Y_{23311}
410	Z_{233212}	400	Z_{133212}	850	Y_{23312}

5- Conclusions:

It has been achieved to reduce supply chain costs by using well-known mathematical methods. In Baghdad Soft Drinks Company, a mathematical model was adopted to reduce the costs of production, storage, transportation, and utilization of all available resources in the company to ensure consumer demand and ensure the required quality. The total cost (production, storage, and transportation) for the two families was (250,750) and for the three products for each family (Pepsi, Seven, Miranda), for the year 2019 (825,843,231), noting that the total cost for the same families and the same year was (910,507,000), a difference (84,663,769), which is the profits of the company If approved. Filling the market needs with the same quality of work in the normal time and not needing to work overtime costs the company large additional sums. Take advantage of the existing storage to fill the agent's request during the maintenance and sterilization period of the production lines, and this leads to reducing the costs of storage and preserving products from damage, and making use of the storage in the agents 'stores to meet their requests during the maintenance and sterilization periods in the company.

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تصميم نموذج سلسلة توريد لشركة بغداد للمشروبات الغازية

الباحث/ سهير سعد فاضل
جامعة الفرات الاوسط التقنية
معيدة في الكلية التقنية المسيب

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المستخلص:

في هذا البحث تم بناء نموذج رياضي لسلسلة التوريد لتقليل تكلفة الإنتاج والمخزون والنقل في شركة بغداد للمشروبات الغازية. تم استخدام طريقة البرمجة الخطية لحل هذا النموذج الرياضي. قمنا بتخفيض تكلفة الإنتاج من خلال تقليل ساعات العمل اليومية ، فلا تحتاج الشركة لساعات عمل إضافية تعمل بنفس مستويات الإنتاج . وتم تخفيض تكاليف التخزين في مستودعات الشركة ومخازن الوكلاء من خلال الاستفادة من المخزون بشكل صحيح مما يضمن تقليل التكاليف والحفاظ على المنتجات من التلف. وكانت الوحدات المنقولة من الشركة مساوية للوحدات التي طلبها الوكلاء. كما حقق النموذج الرياضي للشركة أرباحاً بمقدار (84.663.769) من خلال خفض إجمالي التكاليف إلى (825.843.231) بينما كانت التكلفة الإجمالية في الشركة (910.507.000).

المصطلحات الرئيسة للبحث: البرمجة الخطية ، سلسلة التوريد ، خزين محكم.