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# Introduce a model to determination the optimum amounts of supply indexes by use of Analytical Hierarchy process (AHP) in supply chain management

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### ABSTRACT

In this article, the main aim is determination the optimum amounts of major supply indexes of producers to the optimum supply of their consumption raw materials in supply chain management. The considered indexes in this article are: supply cost, supply time and supply quality status. In this article tried that with consider to amounts of each supply indexes in terms of producers and also maximum capacity of each suppliers in terms of each supply indexes, be calculated the optimum amounts of each supply index. In this model with the use of bipolar scale space technique, convert the qualitative values to numerical values and the use of Entropy technique to determination the weighted matrix and the use of Analytical Hierarchy process (AHP) to determination the supply optimum amounts for each supply indexes.

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### Introduction

These days, daily increasing of competitive conditions in markets, customer services and essential progress in information technology and communication industries caused to satisfying the customers in appropriate quality of product or service, low price in comparison to other competitive and on time delivery of product or service, has the essential role in remaining of organizations at markets and getting the market's proportion. For this reason the concept of supplying chain management is posed during these two decades.

Supply process in a supply network, the supplier in next step as a customer for the supplier in current step. Each supplier is customers for some suppliers and supplier for some other suppliers during supply process and during supply steps and should be mention that supply chain strategies in terms of supply networks is studied.

The aim of this study is the main aim is determination the optimum amounts of major indexes of producers to the optimum supply of their consumption raw materials in supply chain management. The considered indexes in this article are: supply cost, supply time and supply quality status. In this article tried that with consider to amounts of each supply indexes in terms of producers and also maximum capacity of each suppliers in terms of each supply indexes, be calculated the optimum amounts of each supply indexes. In this model with the use of bipolar scale space technique, convert the qualitative values to numerical values and the use of Entropy technique to determination the weighted matrix and the use of combined placement issues in the square of the Euclidean distance to determination the supply optimum amounts for each supply indexes.

Much research has been done in this issue, some of which that: with the aim of developing a phase multi-purposed model for equalizing the use of transportation machines in logistic system, have considered this issue (Ghazanfari, khalili-dizaj, 2004). Was choosing as case study with the purpose of decreasing the transportation costs in iran khodro Company

(Asghari, Aghdasi, 2004). Have presented a model for determining the order point and optimizing the size of order considering the transportation costs (Teimouri, Ghiyami, 2004). Have presented some models for integrating the total logistic cost in supplying chain management (Ghazanfari, Seyed Hosseini, 2004). Have practiced to the development of a model for optimizing the total cost of logistic distribution in conditions of a producer and some distributed warehouses in supply chain management (Ghazanfari, Seyed Hosseini, 2004). by presenting a mathematical Mosel, have practiced to lowering the transportation costs and existence in a production company which the production have been done in some stages and considering the limitation of time for producing a part till requested time to transportation (Watanabe and et.al, 1994).

The main reasons for doing this research are:

- 1) Improving the transportation total expected costs of raw materials in supply chain management.
- 2) Improving the transportation total expected time of raw materials in supply chain management
- 3) Improving the transportation total expected supply quality status of raw materials in supply chain management.
- 4) Smoothing transportation operations throughout the supply chain and supply network.

### Literature Review

#### Supply Chain

Supplying chain consists of material stream, money and information between supplier's network, transportation, producer, distribution network and final customer (Javid, 2004).

#### Supply chain management

Supply chain management (SCM) is the management of a network of interconnected businesses involved in the provision of product and service packages required by the end customers in a supply chain. Supply chain management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption (Javid, 2004).

**Supply Network**

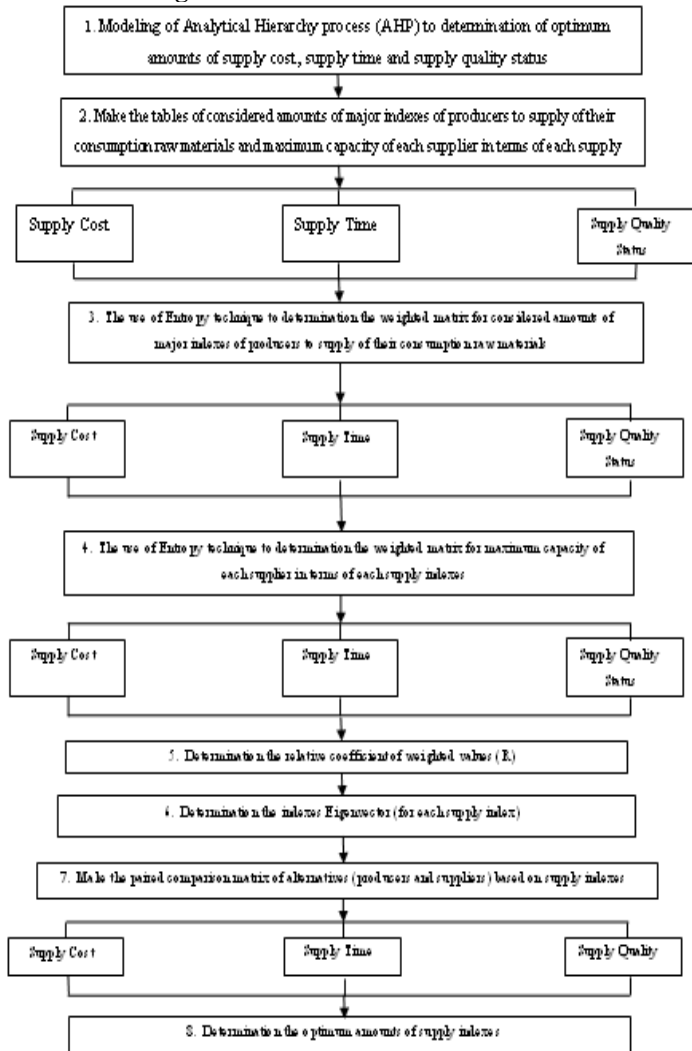
A supply network is a pattern of temporal and spatial processes carried out at facility nodes and over distribution links, which adds value for customers through the manufacturing and delivery of products. It comprises the general state of business affairs in which all kinds of material (work-in-process material as well as finished products) are transformed and moved between various value-added points to maximize the value added for customers (Javid, 2004).

**Research Methodology**

**Case Study**

Consider a supply chain that includes three main suppliers and two producers. These two producers are as customer demands suppliers. Capacity of each supplier is determined by industrial experts. Per unit cost of supplying (currency based) and supply time (time based) and supply quality status (bipolar index space) is determined.

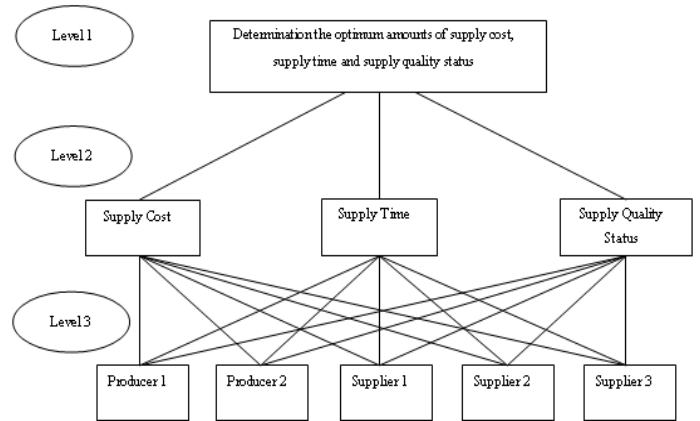
**Figure 1: Research Practical Model**



**Modeling of Analytical Hierarchy process (AHP) to determination of optimum amounts of supply cost, supply time and supply quality status**

In this step of research, make the Analytical Hierarchy process model to determination of optimum amounts of supply cost, supply time and supply quality status. This model is composed of three levels. The First level shows that aim of study, the second level shows that indexes of study and the third level show that the alternatives of study:

**Figure 2: levels of supply in management in this study**



**Make the tables of considered amounts of major indexes of producers to supply of their consumption raw materials and maximum capacity of each supplier in terms of each supply indexes**

In this step of research, make the tables of considered amounts of major indexes of producers to supply of their consumption raw materials and maximum capacity of each supplier in terms of each supply indexes. These indexes are main indexes in determination the optimum relationship between producers and suppliers in supply chain:

**The use of Entropy technique to determination the weighted matrix for considered amounts of major indexes of producers to supply of their consumption raw materials**

In this step of study, the main aim is determination the weighted matrix for considered amounts of major indexes of producers to supply of their consumption raw materials. The weighted matrix in this step shows that importance of considered major indexes of producers to supply of their consumption raw materials:

The steps of this section are:

1. Make the decision making matrix

$$\begin{bmatrix} 3 & 3 & 9 \\ 2 & 4 & 7 \end{bmatrix} = A$$

2. Determination the weighted matrix by using of entropy technique

2.1. Determination the P matrix:

$$P = \begin{bmatrix} 0.6 & 0.428 & 0.562 \\ 0.4 & 0.571 & 0.437 \end{bmatrix}$$

2.2. Determination the E<sub>j</sub> matrix:

$$E_j = [0.97 \quad 0.985 \quad 0.99]$$

2.3. Determination the É<sub>j</sub> matrix:

$$\acute{E} = 1 - E_j = [0.015 \quad 0.03 \quad 0.01]$$

2.4. Determination the É<sub>j</sub> matrix:

$$W_j = \acute{E}_j \div \sum \acute{E}_j$$

$$W_j = [0.545 \quad 0.272 \quad 0.182]$$

The use of Entropy technique to determination the weighted matrix for maximum capacity of each supplier in terms of each supply indexes

The steps of this section are:

1. Make the decision making matrix

$$A = \begin{bmatrix} 4 & 2 & 7 \\ 3 & 3 & 5 \\ 2 & 4 & 5 \end{bmatrix}$$

2. Determination the weighted matrix by using of entropy technique

2.1. Determination the P matrix:

$$p = \begin{bmatrix} 0.444 & 0.222 & 0.411 \\ 0.333 & 0.333 & 0.294 \\ 0.111 & 0.444 & 0.294 \end{bmatrix}$$

2.2. Determination the E<sub>j</sub> matrix:

$$E_j = [0.883 \quad 0.966 \quad 0.988]$$

2.3. Determination the É<sub>j</sub> matrix:

$$\dot{E}_j = 1 - E_j = [0.117 \quad 0.034 \quad 0.012]$$

2.4. Determination the É<sub>j</sub> matrix:

$$W_j = \dot{E}_j \div \sum \dot{E}_j$$

$$W_j = [0.717 \quad 0.208 \quad 0.073]$$

#### Determination the relative coefficient of weighted values (R)

In this step of study, according to the calculated values of weighted matrices for considered amounts of major indexes of producers to supply of their consumption raw materials and maximum capacity of each supplier in terms of each supply indexes, will be calculated the coefficient of relative weighted (R). The coefficient of relative weighted shows that the relative importance of supply indexes in terms of maximum capacity of each suppliers and considered amounts of major indexes of producers to supply of their consumption raw materials:

$$R_i = \frac{W_i (\text{suppliers})}{W_i (\text{producers})}, \quad i = 1,2,3$$

$$R_1 = \frac{W_1 (\text{suppliers})}{W_1 (\text{producers})} = \frac{0.717}{0.545} = 1.315$$

$$R_2 = \frac{W_2 (\text{suppliers})}{W_2 (\text{producers})} = \frac{0.208}{0.272} = 0.764$$

$$R_3 = \frac{W_3 (\text{suppliers})}{W_3 (\text{producers})} = \frac{0.073}{0.182} = 0.401$$

#### Determination the indexes Eigenvector (for each supply index)

In this step of study, the main aim is determination the indexes eigenvector with the use the relative coefficient of weighted values matrix (R). To calculate the values of indexes eigenvector, calculate the Geometric mean in each row of table5. Finally, divide the calculated values on summation of calculated values:

#### Make the paired comparison matrix of alternatives (producers and suppliers) based on supply indexes

In this step of study, the main aim is Paired comparison of alternatives (producers and suppliers) based on supply indexes. The use of relationship scores (in locating problem issue) to determination values the paired comparison matrix base on supply indexes:

Therefore, the paired comparison matrix of alternatives (producers and suppliers) based on supply indexes are:

#### The paired comparison matrix of alternatives (producers and suppliers) based on supply cost

In this step of study, will be calculated geometric mean and eigenvectorfor alternatives based on supply cost. To calculate the values of indexes eigenvector, calculate the Geometric mean in each row of table 10:

#### The paired comparison matrix of alternatives (producers and suppliers) based on supply time

In this step of study, will be calculated geometric mean and eigenvectorfor alternatives based on supply time. To calculate the values of indexes eigenvector, calculate the Geometric mean in each row of table 11:

#### The paired comparison matrix of alternatives (producers and suppliers) based on supply quality status

In this step of study, will be calculated geometric mean and eigenvectorfor alternatives based on supply quality status. To calculate the values of indexes eigenvector, calculate the Geometric mean in each row of table 12:

#### Determination the optimum amounts of each supply index

In this step of study, will be calculated the score of each alternative. Each alternative that has been higher score, is optimum alternative and its amounts of each supply index, is optimum amounts of each supply index:

Score of Alternative i:  $\sum ((E.A)_i \times (E.I)_i)$

$$\text{Score of Producer1} = 0.191 \times 0.718 + 0.215 \times 0.208 + 0.202 \times 0.073 = 0.1966$$

$$\text{Score of Producer2} = 0.228 \times 0.718 + 0.2018 \times 0.208 + 0.223 \times 0.073 = 0.2219 *$$

$$\text{Score of Supplier1} = 0.221 \times 0.718 + 0.2018 \times 0.208 + 0.217 \times 0.073 = 0.2165$$

$$\text{Score of Supplier2} = 0.173 \times 0.718 + 0.2018 \times 0.208 + 0.169 \times 0.073 = 0.1785$$

$$\text{Score of Supplier3} = 0.186 \times 0.718 + 0.181 \times 0.208 + 0.188 \times 0.073 = 0.1849$$

According to scores of producers and suppliers, producer2 has higher score than other alternatives. Therefore, it's considered amounts of supply indexes are as optimum amounts of supply indexes:

Optimum supply cost is: 2

Optimum supply time is: 4

Optimum supply quality status is: 7 (good)

#### Conclusion and suggestion

According to the results of doing this research, the role of optimization of supply indexes in supply chain management, is a vital affair for every production or service organization. In fact the determining an accurate program for implementation of transportation process and feeding of producers according to the changing in supply orders, is an important competitive advantage for every organization.

According to the obtained results from optimization of supply indexes in supply chain management the decreasing of cost and time and increasing quality status in transportation total expected in parts transportation in order to feeding of producers will be observed. According to the obtained results, producer1 proposed amounts of supply indexes as optimum amounts of supply indexes and optimum supply cost is 2 (cost based), optimum supply time is 4 (time based) and Optimum supply quality status is: 7 (good). Because of variety of variations, it is not possible to control the total variations that mean that some impressive variations on the result of research are out of control. So, it is suggested that the related researches in this filed should be done by all impressive variations.

As for the optimization of supply indexes in supply chain management and it's relating to the costs is a new issue in Iranian organizations, so in considering of its indexes and in organizations and filed study, this research has been faced with the previous researches limitations.

**Table 1. Amounts of major indexes of producers to supply of their consumption raw materials**

Producers \ Index	Supply Cost	Supply Time	Supply Quality status (Based on bipolar scale space technique)	
	Producer 1	3	3	Very Good
Producer 2	2	4	Good	7

**Table 2. Maximum capacity of each supplier in terms of each supply indexes**

Suppliers \ Index	Supply Cost	Supply Time	Supply Quality status (Based on bipolar scale space technique)	
	Supplier 1	4	2	Good
Supplier 2	3	3	Fair	5
Supplier 3	1	4	Fair	5

**Table 3. Amounts of major indexes of producers to supply of their consumption raw materials**

Producers \ Index	Supply Cost	Supply Time	Supply Quality status (Based on bipolar scale space technique)	
	Producer 1	3	3	Very Good
Producer 2	2	4	Good	7

**Table 4. Maximum capacity of each supplier in terms of each supply indexes**

Suppliers \ Index	Supply Cost	Supply Time	Supply Quality status (Based on bipolar scale space technique)	
	Supplier 1	4	2	Good
Supplier 2	3	3	Fair	5
Supplier 3	1	4	Fair	5

**Table 5. Eigenvector for indexes (E.I)**

Supply index of producers \ Supply index of suppliers	Supply Cost	Supply Time	Supply Quality Status	Geometric Mean	Eigenvector for indexes (E.I)
Supply Cost	1.315	2.636	3.939	2.39	0.718
Supply Time	0.381	0.764	1.142	0.692	0.208
Supply Quality Status	0.134	0.268	0.401	0.243	0.073

**Table 6. Standard scores the relationships between departments**

Relationship	Score	Closeness Degree
A	4	Absolutely necessary
E	3	Especially important
I	2	Important
O	1	Ordinary closeness
U	0	Unimportant
X	-1	X

**Table 7. The closeness relationships between producers and suppliers in terms of supply cost**

Supplier \ Producer	Producer 1	Producer 2	Supplier 1	Supplier 2	Supplier 3
Producer 1	O 1	E 3	E 3	E 3	I 2
Producer 2	E 3	O 1	A 4	E 3	E 3
Supplier 1	E 3	A 4	O 1	I 2	A 4
Supplier 2	E 3	E 3	I 2	O 1	I 2
Supplier 3	I 2	E 3	A 4	I 2	O 1

**Table 8. The closeness relationships between producers and suppliers in terms of supply time**

Supplier Producer	Producer 1		Producer 2		Supplier 1		Supplier 2		Supplier 3	
Producer 1	O	1	I	2	E	3	A	4	A	4
Producer 2	I	2	O	1	A	4	E	3	E	3
Supplier 1	E	3	A	4	O	1	E	3	I	2
Supplier 2	A	4	E	3	E	3	O	1	I	2
Supplier 3	A	4	E	3	I	2	I	2	O	1

**Table 9. The closeness relationships between producers and suppliers in terms of supply quality status**

Supplier Producer	Producer 1		Producer 2		Supplier 1		Supplier 2		Supplier 3	
Producer 1	O	1	E	3	A	4	I	2	I	2
Producer 2	E	3	O	1	A	4	I	2	E	3
Supplier 1	A	4	A	4	O	1	I	2	I	2
Supplier 2	I	2	I	2	I	2	O	1	E	3
Supplier 3	I	2	E	3	I	2	E	3	O	1

**Table 10. The geometric mean and eigenvector for alternatives based on supply cost**

Based on Supply Cost	P 1(Producer 1)	P 2	S 1(Supplier 1)	S 2	S 3	Geometric Mean	Eigenvector for Alternatives (E.A)
P 1	1	3	3	3	2	2.71	0.191
P 2	3	1	4	3	3	3.223	0.228
S 1	3	4	1	2	4	3.13	0.221
S 2	3	3	2	1	2	2.449	0.173
S 3	2	3	4	2	1	2.632	0.186

**Table 11. The geometric mean and eigenvector for alternatives based on supply time**

Based on Supply Time	P 1(Producer 1)	P 2	S 1(Supplier 1)	S 2	S 3	Geometric Mean	Eigenvector for Alternatives (E.A)
P 1	1	2	3	4	4	3.13	0.215
P 2	2	1	4	3	3	2.913	0.2018
S 1	3	4	1	3	2	2.913	0.2018
S 2	4	3	3	1	2	2.913	0.2018
S 3	4	3	2	2	1	2.632	0.181

**Table 12. The geometric mean and eigenvector for alternatives based on supply quality status**

Based on Supply Quality Status	P 1(Producer 1)	P 2	S 1(Supplier 1)	S 2	S 3	Geometric Mean	Eigenvector for Alternatives (E.A)
P 1	1	3	4	2	2	2.632	0.202
P 2	3	1	4	2	3	2.913	0.223
S 1	4	4	1	2	2	2.828	0.217
S 2	2	2	2	1	3	2.213	0.169
S 3	2	3	2	3	1	2.449	0.188

**Table 13. Eigenvector for each alternative based on each supply index (E.A)**

Alternative	Supply Cost	Supply Time	Supply Quality Status
Producer 1	0.191	0.215	0.202
Producer 2	0.228	0.2018	0.223
Supplier 1	0.221	0.2018	0.217
Supplier 2	0.173	0.2018	0.169
Supplier 3	0.186	0.181	0.188

Also it is suggested that research in this field should be done by impressive various indexes in supply chain management systems and different organizations.

As for various producers and suppliers in supply chain and supply network, in this study, just considered a few number of producers and suppliers in supply chain and supply network. So, we suggest that the related research in this field, with regards of the total producers and suppliers, should be done.

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2. Asgari, Nasrin and Aghdasi, Mohammad (2004) also was choosing as case study with the purpose of decreasing the transportation costs in Iran Khodro Company.
3. Teimouri, Ebrahim and Ghiyami Yousef (2004) also have presented a model for determining the order point and optimizing the size of order considering the transportation costs.
4. Ghazanfari, Hossein and Seyed Hosseini Seyed Mohammad (2004) have presented some models for integrating the total logistic cost in supplying chain management.
5. Ghazanfari, Hossein and Hosseini, Seyed Mohammad (2004), have practiced to the development of a model for optimizing the total cost of logistic distribution in conditions of a producer and some distributed warehouses in supplying chain management.
6. Watanabe and et.al (1994) by presenting a mathematical model, have practiced to lowering the transportation costs and existence in a production company which the production have been done in some stages and considering the limitation of time for producing a part till requested time to transportation.
7. Nozick and Turnquist (2000), as for theory of integrating process, transportation cost and facilities cost and existence, have presented a mathematical model and for considering the performance of the presented model, they have opted a car making factory as a case study.
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9. Nishazaki (2001) and et.al also modeled this matter as a phase modeling. In this study the purpose function is for decreasing the cost of transportation, travel time and the number of vehicle.
10. Bamol and Winod (1993), have done the first prompts for determining the transportation vehicle in an alone product more which could be a model of decreasing the existence and transportation cost.
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