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Introduce a model for determining the critical supply routes and amount of optimum supply able demand in each supply activity and the rating of critical network paths by using of Topsis method

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ABSTRACT

This article determined the critical supply routes with three approaches: cost, time and supply quality status and rating of supply critical routes in a network supply, finally. In this article, has tried that each three parameter: supply cost, supply time and supply quality status having an effective and efficient supply network and supply chain are very effective, considered in determine of supply critical paths in a supply network. It is important that the network be effective and efficient, cause to rapidly response to receive demands with higher quality and gain competitive advantage in competitive market and effective chain management.

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.

A demand-supply network is a network of suppliers and customers that should be considered in the process of supplying 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 to determine the supply critical activities and paths in the network. The supply critical activity is an activity that be allocated during implementation of the proposed algorithm to the activity to supply a certain amount of demand in each of the steps of problem solving by using Vogel's Approximation Method(VAM) with respect to each of the parameters: X1, X2, X3 is repeated. In other words, the supply critical activity is an activity that any iteration of the table Vogel method according to three parameters: X1, X2, X3, is done, the related box to that activity is not empty and to that box, is allocated some demand for supply. Each supply critical path is a combination of two more successive supply critical activities.

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).

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Critical Path

The Critical Path, the longest necessary path through a network of activities when respecting their interdependencies, which may be identified with the Program Evaluation and Review Technique and the Critical path method (Javid, 2004).

Research Methodology

Case Study

Consider a supply network that includes two sub-suppliers, the three main suppliers and two sub-producers. These two main 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.

Design a supply network according to suppliers' relations

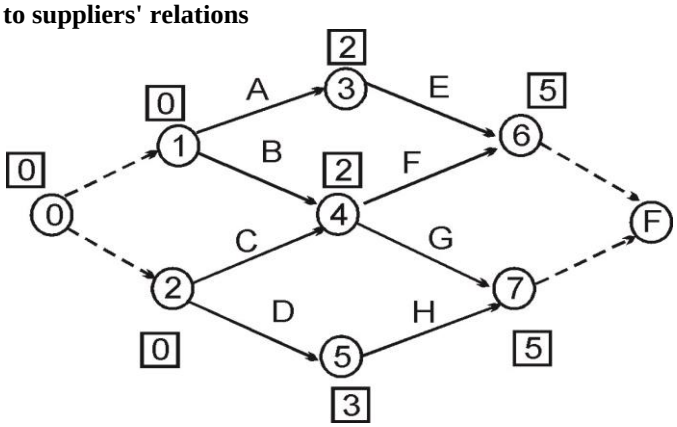

Figure 2: Supply Network Designed

Sub-supplier main supplier main producer

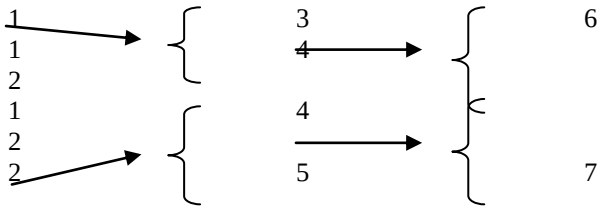

Table 1: Capacities and Conditions for each supply activity

Supply activity	Supply capacity in usual condition	Supply cost per unit (currency based)	Supply time (time based)	Supply quality status
A	2	1	2	Very high
B	1	1	1	High
C	2	2	1	Very good
D	3	1	2	Good
E	3	3	1	Good
F	2	2	1	Middle
G	1	2	2	Good
H	2	4	2	Very good

Determination the number of supply network sections (network cutting)

This supply network has two sections (cutting):

First supply network section (First cutting)

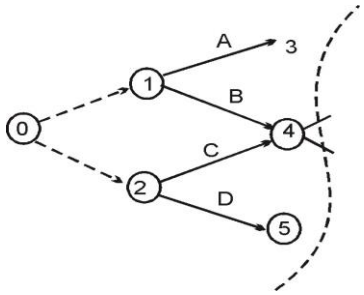

Figure 3: First supply network section (First cutting)

Second supply network section (Second cutting)

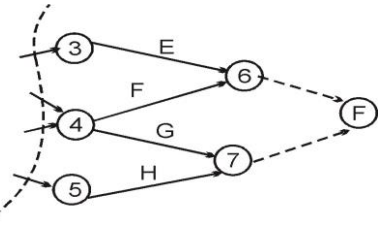

Figure 4: Second supply network section (Second cutting)

Determination of supply able demand by each activity by using Vogel method in first supply network section

Supply cost approach

Table 2: Supply cost approach finally table by Vogel method

Demander / supplier	1	2	3	X
1-A	2 **1**			
1-B		**1**		1
2-C		2 **2**		
2-D			3 **1**	

Z c = 2×1+2×2+3×1=**9**

Supply time approach

Table 3: Supply time approach finally table by Vogel method

Demander / supplier	1	2	3	X
1-A	2 **2**			
1-B		1 **1**		1
2-C		1 **1**		1
2-D			3 **2**	

Z T = 2×2+1×1+1×1+3×2=**12**

Supply quality status approach (by using bipolar index space method)

Table 4: Supply quality status approach finally table by Vogel method

Demander / supplier	1	2	3	X
1-A	2 **9**			
1-B		0 **7**		1
2-C		2 **9**		1

2-D				**3** **7**	

Z Q = 2×9+2×9+3×7=**57**

3.4. Determination of supply able demand by each activity by using Vogel method in second supply network section

3.4.1. Supply cost approach

Table 5: Supply cost approach finally table by Vogel method

Demander / supplier	**6**	**7**	**Amount of supply**
3-E	**3** **3**		**3 – x**
4-F	**2** **2**		**2+y**
4-G		**1** **2**	**1+z**
5-H		**2** **4**	**2+w**

Because, amount of supply is less than two units of demand, must be compensate for this deficiency through increasing capacity of a supplier. To this end, suppose that maximum capacity increasing by each supplier in this section with approaches supply cost, time and quality status is:

Table 6: maximum capacity increasing for each supply activity

Supply activity	**maximum capacity increasing**
3-E	X
4-F	Y
4-G	Z
5-H	w

According to table 5, amount of x, y = 0. To determination amount of supply for boxes: (4-G) → 7 and (5-H) → 7, there are three situations:

Table 6: Situations of allocation

Cost	**(4-G)→ 7**	**(5-H)→ 7**	**Supply path situation**
6=2×1+4×1	1	1	**first**
8=2×0+4×2	0	2	**second**
4=2×2+4×0 *****	2	0	**third**

$x + y + z + w = 2$, $\mathbf{w = 0, z = 2}$

Table 7: amount of supply by each supply activity

Amount of supply	**Supply activity**
3	3-E
2	4-F
3=2+1	4-G
2	5-J

Supply time approach

Table 8: Supply time approach finally table by Vogel method

Demander / supplier	6	7	Amount of supply
3-E	3 **1**		3 – x
4-F	2 **1**		2+y
4-G		1 **2**	1+z
5-J		2 **2**	2+w

$x + y + z + w = 2$, $z + w = 2 \rightarrow x = 0, y = 2$

Because amounts of allocation time are same between each three situations, therefore face to three situations:

1) Z=0, w=2
2) Z=1, w=1
3) Z=2, w=0

Table 9: Situations of allocation

Time	(4-G)→ 7	(5-H)→ 7	Supply path situation
4=2×1+2×1 *	1	1	**first**
4=2×0+2×2 *	0	2	**second**
4=2×2+2×0 *	2	0	**third**

Table 10: amount of supply by each supply activity

Amount of supply	Supply activity
3	3-E
2	4-F
1,2,3	4-G
4,3,2	5-J

Supply quality status approach (by using bipolar index space method)

Table 11: Supply quality status approach finally table by Vogel method

Demander / supplier	6	7	Amount of supply
3-E	3 **7**		3 – x
4-F	2 **5**		2+y
4-G		1 **7**	1+z
5-J		2 **9**	2+w

Table 12: Situations of allocation

Time	(4-G)→ 7	(5-H)→ 7	Supply path situation
16=7×1+9×1	1	1	**first**
18=7×0+9×2 *	0	2	**second**
14=7×2+9×0	2	0	**third**

$x + y + z + w = 2$, $z + w = 2 \rightarrow x = 0, y = 2$, $w = 2 \rightarrow z = 0$

Determination of supply activities in first and second supply network sections

To determine of supplying critical activities, boxes of tables: 2, 3, and 4 are selected that are allocated to supplying.

According to selected supply critical activities in first section, supply critical activities are:

1-A 3 ⟶
2-C 4 ⟶
2-D 5 ⟶

According to selected supply critical activities in second section, supply critical activities are:

3-E 6 ⟶
4-F 6 ⟶
4-G 7 ⟶
5-H 7 ⟶

3.5. Determination of supply critical paths

1-3-6, 2-4-6, 2-4-7, 2-5-7

3.6. Classifying of network critical paths by Topsis method to determination of optimum supply paths

According to determination of optimum supply network, table 13 with four alternatives (critical paths) and three indexes: supply cost, time and quality status is made to finally decision making.

Table 13: Initial table to selecting optimum critical path

Index / Alternative	Cost	Time	Quality status
1-3-6 (A1)	11=3×3+1×2	7=1×3+2×2	39=7×3+9×2
2-4-6 (A2)	8=2×2+2×2	3=1×2+1×1	28=5×2+9×2
2-4-7 (A3)	10=2×3+2×2	5=2×2+1×1	25=7×1+9×2
2-5-7 (A4)	11=4×2+1×3	9=2×3+1×3	57=9×4+7×3

Data Analyzing

The final results of classifying critical paths (Alternatives) to determination of optimum supply path in supply network

Table 14: The final results of classifying critical paths

Alternative	Classifying
A1	2
A2	1 *
A3	4
A4	3

According to table 14, the optimum critical path in supply net work is: 2-4-6

Conclusion and suggestion

In this study, path: 2-4-6 is selected as the optimum critical path in supply network. According to this path, optimum supply cost is: 8 (currency based) and optimum supply time is: 3 (time based) and optimum quality status is: 28 (quality based). This model can help to selecting of optimum supplier in a supply network or supply chain. Propose that this model use in real conditions with real data and limitations.

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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 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.
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