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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.*

***Keywords***: Supply Critical Route, Supply Network, Supply Chain, Supply Chain Management, Supply Cost, Supply Time, Supply Quality Status.

## INTRODUCTION AND PROBLEM STATEMENT

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).

### 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

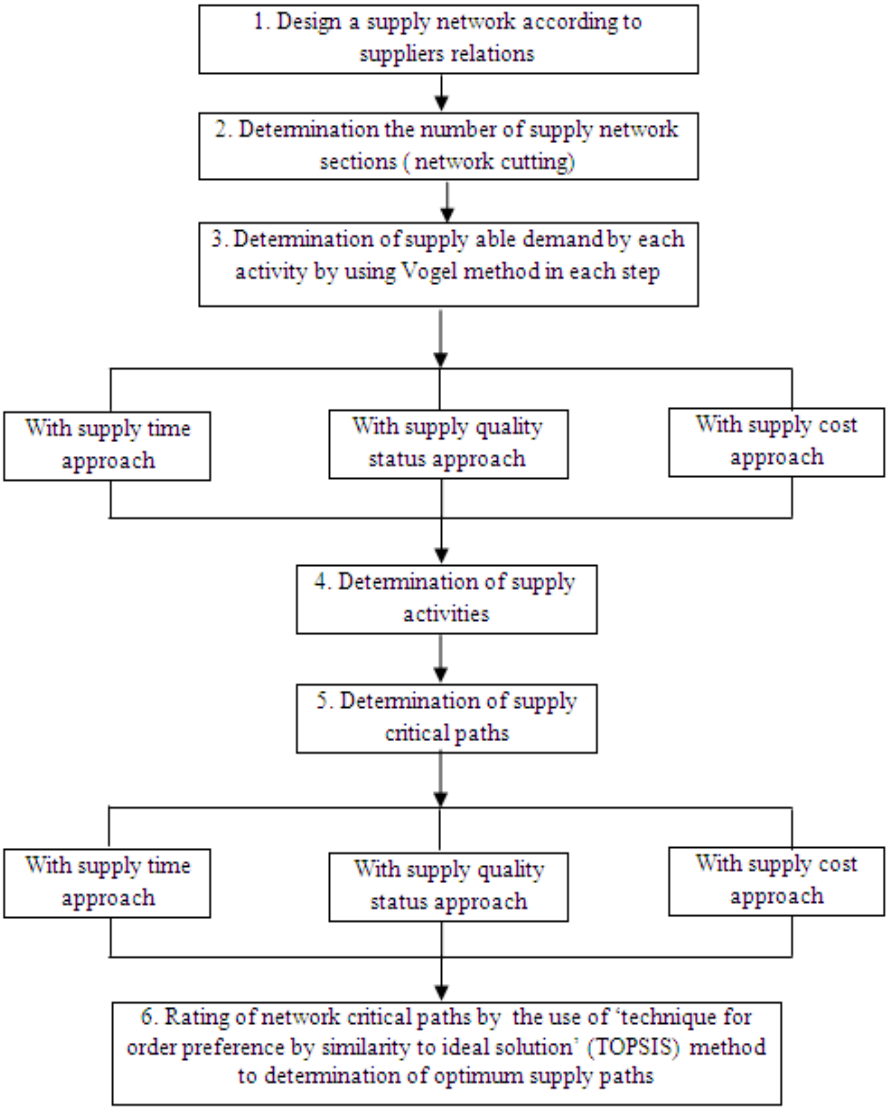
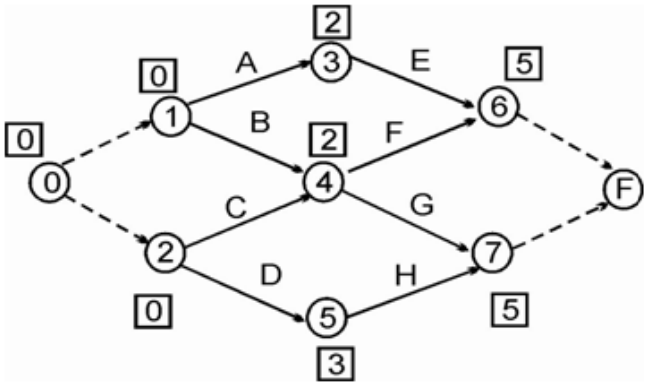



**Figure 1.** Research Practical Model

### 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**



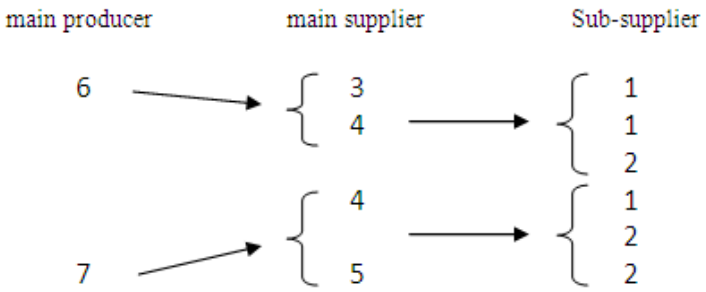




**Figure 2.** Supply Network Designed

**Table 1.** Capacities and Conditions for each supply activity

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

**Determination the Number of Supply Network Sections (Network Cutting)**

This supply network has two sections (cutting):

**First Supply Network Section (First Cutting)**

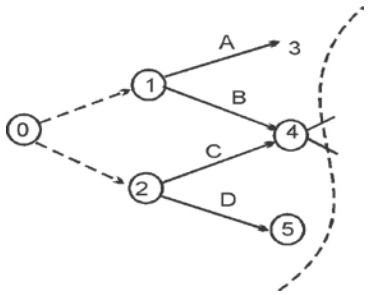



**Figure 3.** First supply network section (First cutting)

**Second Supply Network Section (Second Cutting)**

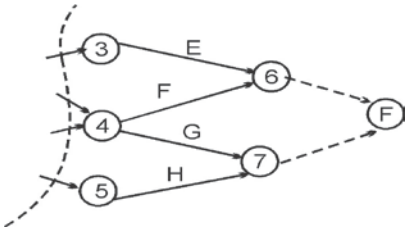



**Figure 4.** Second supply network section (Second cutting)

**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) | |

$Z_T = 2\times2+1\times1+1\times1+3\times2=12$

**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) | |

$Z_Q = 2\times9+2\times9+3\times7=57$ **supply**

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

**Supply cost approach**

**Table 5.** Supply cost approach finally table by Vogel method

| Demander / Supplier | 6 | 7 | Amount of |
|---|---|---|---|
| 3-E | (3) | | 3 – x |
| 4-F | 2 (2) | | 2+y |

**Table 5.** Supply cost approach finally table by Vogel method (Contd….)

| | | | |
|---|---|---|---|
| **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 7.** Situations of allocation

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

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

According to amounts of supply in table 5 and the values obtained for the variables : ( x, y, z, w) in this part of the research, table 7 shows that the optimum demand for any supply activity, is make.

**Table 8.** Amount of optimum supply by each supply activity in this part

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

**Supply Time Approach**

**Table 9.** Supply time approach finally table by Vogel method

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

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

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 10.** Situations of allocation

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

According to amounts of supply in table 9 and the values obtained for the variables : ( x, y, z, w) in this part of the research, table 11 shows that the optimum demand for any supply activity, is make.

**Table 11.** Amount of optimum supply by each supply activity in this part

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

**Supply Quality Status Approach (By Using Bipolar Index Space Method)**

**Table 12.** 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 13.** Situations of allocation

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

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

According to amounts of supply in table 12 and the values obtained for the variables : ( x, y, z, w) in this part of the research, table14 shows that the optimum demand for any supply activity, is make.

**Table 14 .** Amount of optimum supply by each supply activity in this part

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

**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

**Determination of supply critical paths**

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

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

According to determination of optimum supply network, table 14 with four alternatives (critical paths) and three indexes: supply cost, time and quality status is made to finally decision making.

**Table 15.** Initial table to selecting optimum critical path

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

## RESULTS AND DISCUSSION

### Determination the Optimum Supply Amount for Any Supply Activity

**In first supply network section (First cutting)**

**Table 16.** The optimum supply amount in first supply network section

| In terms of: Cost | | In terms of: Time | | In terms of: Quality Status | |
|---|---|---|---|---|---|
| **Supply Activity** | **The optimum amount** | **Supply Activity** | **The optimum amount** | **Supply Activity** | **The optimum amount** |
| 1-A | 2 | 1-A | 2 | 1-A | 2 |
| 2-C | 2 | 1-B | 1 | 2-C | 2 |
| 2-D | 3 | 2-C | 1 | 2-D | 3 |
| | | 2-D | 3 | | |

Table 16 shows that the optimum supply amounts in terms of indexes: supply cost, supply time and supply quality status in first supply network section.

**In second supply network section (second cutting)**

**Table 17.** The optimum supply amount in second supply network section

| In terms of: Cost | | In terms of: Time | | In terms of: Supply Quality Status | |
|---|---|---|---|---|---|
| **Supply Activity** | **The optimum amount** | **Supply Activity** | **The optimum amount** | **Supply Activity** | **The optimum amount** |
| 3-E | 3 | 3-E | 3 | 3-E | **3** |
| 4-F | 2 | 4-F | 2 | 4-F | **2** |
| 4-G | 3 | 4-G | 2 | 4-G | **1** |
| 5-H | 2 | 5-H | 3 | 5-H | **4** |

Table 17 shows that the optimum supply amounts in terms of indexes: supply cost, supply time and supply quality status in second supply network section.

Determination the optimum critical paths and their values in terms of indexes: supply cost, supply time and supply quality status.

**Table 18.** The optimum critical paths

| Index | The Optimum Critical Path | Optimum Value |
|---|---|---|
| Cost | 2-4-6 | 8 |
| Time | 2-4-6 | 3 |
| Quality Status | 2-5-7 | 57 |

Table 18 shows that the optimum critical paths in terms of indexes: supply cost, supply time and supply quality status in supply network.

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

**Table 19.** The final results of classifying critical paths

| Alternative | Classifying |
|---|---|
| 1-3-6 (A1) | 2 |
| 2-4-6 (A2) | 1 * |
| 2-4-7 (A3) | 4 |
| 2-5-7 (A4) | 3 |

Table 19 shows that the optimum critical path in terms of all indexes: supply cost, supply time and supply quality status in supply network is: 2-4-6.

The aim of this study is determination the optimum supply paths and optimum suppliers in any supply sections and their optimum amounts in terms of: supply cost, supply time, supply quality status and all indexes to better response to receive orders. Determination the critical path in a supply network in terms of any indexes motive to enhanced power management decisions when faced with decision making in different situations due to market fluctuations and customers orders. The outputs this supply plan is suppliers' selection at each level of the

supply and determination the supply optimum amounts by any supplier. According to optimum critical path in terms of all indexes, 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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