Analyzing problems and optimization of supply chain in different industries using SAW and TOPSIS methods

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Abstract

Due to high level competition in market, effective supply chain management has become a potentially important tool for gaining and effective competitive advantage and refining organizational performance, because the competition is not only amongst companies but also between supply chains. Supply chain plays a significant role in company’s performance. Companies are challenged to explore ways to meet the customer demands and satisfaction at a manageable cost. To achieve this, business must find which parts of supply chain process are competitive and can be optimized with budget constraints meeting customer demands. In any unit it is mandatory to produce a high quality product with minimal budget successfully. Selection of a suitable supplier is equally important due to budget constraints. There are various methods for making the optimize result. In this research paper collecting the data from different industries and optimize the result by selecting TOPSIS and SAW methods for the solution of this problem. In this technique the decision is made by comparing each alternative with the ideal solution, hence delivering the best results.

Keywords: Supply chain, TOPSIS, SAW, Attributes/criteria.

1. Introduction

A supply chain is a unified network of all input data useful for production through the correct channel, it can be individuals, organizations, resources, activities and technologies related to the production and sale of a product or service. The supply chain starts with the delivery of the raw materials (raw materials) from the supplier to the producer and ends with the delivery of the finished product or service (product) to the final consumer / consumer. Supply chain coordination plays an important role in integrating the various actors in any supply chain, which leads to an increase in its efficiency. There are numerous mechanisms by which supply chain partners can coordinate with each other [1]. SCM controls every point of contact for a company's product or service, from initial creation to final sale. With so many places in the supply chain that can increase value by increasing efficiency or losing value by increasing costs, an adequate supply chain management system can increase revenues, reduce costs and affect a company's profits.

In a typical supply chain, the raw materials are purchased and the products are produced in one or more factories, sent to warehouses for intermediate storage and then sent to retailers or buyers. Therefore, in order to reduce costs and increase efficiency, effective levels of service, satisfaction and supply chain strategies must take into account the interaction at various levels in the supply chain.

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2. Importance of supply chain

As we know, an effective supply chain is very important for any organization. Supply chain strategies are now an important force for business organizations. Effective market coverage, a roadmap, the availability of products and their usefulness in any place where there is a key to revenue recognition depends on the effectiveness of the expanded supply chain strategy [14]. Any error that the product is not available at the right time can lead to a decline in interest and demand from the customer, which can be disastrous. The design and management of the transport network is essential to support sales and marketing strategies.

Inventory control and inventory visibility are two very important elements in all successful operations. Because these are factors that influence the cost that directly affect the total budget figures. Inventory means cost and is a resource for a company. Every company has a standard value for inventory turnover that is optimal for a company. Stock turnover refers to cases where the stock was sold and replaced within twelve months.

The status of stock turnover is related to the health of the company. In the global scenario, the final inventory of goods is carried out at many sites and distribution centers managed by third parties. A lot of inventory will also be in sequence in transport, except for inventory with distribution points and retailers.

3. Problems in supply chain management

In today’s difficult conditions, SCM is faced with various problems in various sectors, health sectors and institutions. Industries are becoming increasingly aware of the fact that their ability to gain a competitive advantage in companies can take place through the supply chain.

If we consider the case of companies that operate globally, supply chain strategies increase operational efficiency and affect both the bottom line and the main flow. Unlike technology or other key areas that affect sales / business, the supply chain is always in a dynamic mode [10].

Supply chain project managers have many times encountered many problems and challenges that must be overcome throughout the project. They make every effort to minimize these problems. In this research, we will discuss some practical problems and obstacles encountered in implementing and implementing global supply chain projects.

3.1 Project Scale and Span of Control

There are so many projects distributed globally with the participation of many countries and places where all areas must be launched in the same time frame. Project managers will be in one country and physically the project managers will not be able to continue working in all places and concentrate on all the sites. Without a doubt, project teams are trained at the regional level of the country.

However, if the development, planning and control of the project are carried out by an office, a person or a group, the remaining members of the project group will become executors, which will lead to a decrease in energy and concentration.

Supply chain projects include technology, including infrastructure, in addition to software. They also include diversified logistics, including warehouse, transportation and transportation, etc. The degree of control over the implementation of the project is important in the case of logistics projects and service providers that involve different channels and external and internal agencies. At
best, project managers can focus on implementing a project in a country, depending on the number of sites and logistics components involved. If the project involves the creation of a distribution center or warehouse, there are more and more reasons why the implementation should be limited to the country level.

3.2 Technology

Adopting the right technology and implementation often encounters obstacles in implementing global supply chain projects. Each country has a specific supply chain and all projects implement common processes that must be followed in all countries and regions and include the use of technology to manage these processes. There are so many technological problems in the project:

3.2.1 Technological solutions

In most industries, it turns out that their supply chains are not managed by a single application or a series of applications, but that in every place and country obsolete systems or separate systems will be implemented for the management of individual local logistics activities. After implementation, it becomes difficult to isolate such applications and transfer them to a common platform, without which common processes and standardization cannot be implemented in different places.

Secondly, any software solution must be configured in accordance with local and country site requirements. A solution is not suitable for everyone. Although the solution may work in a country with large volumes and sizes of supply chain networks and warehouses, the same software may not be suitable for deployment in a small country with a single location.

3.2.2 Cost of Technology absorption

The introduction of various technologies requires IT teams to travel to all places, to personalize. It can be based on some software, trains the public and stabilizes the sites after it has been viewed. The implementation cost could be high. Once again, not all countries may be able to bear the costs of this implementation.

3.3 Availability of technological infrastructures

The availability of technological infrastructures is different in different countries and within the country. Internet connectivity and its network may not be the same in all places, which can hinder the implementation of applications based on Internet technologies and artificial smart technologies. In general, if the project is implemented globally, the problems of Local infrastructure in many countries are still not resolved given the suitability of the implementation IT platform.

3.4 The possibility of internal and external resources

Supply chain projects involve multiple offices and departments and cross-functional teams within the organization. It includes several departments for the operation of various operations. In addition, they also include various external agencies and internal agencies that manage logistics.

The availability of quality resources both inside and outside in all places is crucial for the implementation of the project and is often a problem that can delay implementation and training.
4. Methodology:

As discussed earlier SCM has different problems and for getting out these problems we can optimize our results by taking different alternatives/criteria. There are so many different type of optimization technique for getting better result. Multi criteria decision making technique is used to get the beneficial results. In this research paper we are collecting data from three different industries and optimizing results of supplier selection, vendor and product order etc. by using SAW and TOPSIS [5,7] optimization methods and discuss how they affect our supply chain.

5. OPTIMIZATION METHODS

a) TOPSIS method
b) SAW method
c) ANP method
d) AHP method

In this research paper for optimizing the results by taking different alternatives/criteria we are using SAW and TOPSIS method and comparing the results on the basis of these two optimization methods.

6. Analysis:

COMPANY 1

SAW (Simple Additive Weighing)

| Criteria   | Weight | V1 | V2 | V3 | V4 | V5 |
|------------|--------|----|----|----|----|----|
| Weight     | 15     | 70 | 70 | 40 | 65 | 50 |
| Defectives | 15     | 45 | 40 | 30 | 50 | 40 |
| Quality    | 25     | 65 | 45 | 35 | 50 | 40 |
| Time       | 15     | 75 | 55 | 35 | 60 | 45 |
| Cost       | 20     | 50 | 60 | 40 | 60 | 40 |
| Transporta| 10     | 55 | 40 | 30 | 50 | 35 |
| Weighted Score | 100     | 60.25 | 52 | 35.5 | 55.75 | 41.75 |

Vendor Order: V1, V4, V2, V5, V3

TOPSIS METHOD

| Vendor | Wt (kg) | Defectives (%) | Quality (Rating) | Time (Rating) | Cost (Rs/kg) | Transportation Cost (Rs/kg) |
|--------|---------|----------------|------------------|---------------|--------------|-----------------------------|
| V1     | 5000    | 5.0            | Very Good        | Very Good     | 200          | 5                           |
| V2     | 3500    | 5.5            | Good             | Very Good     | 250          | 2                           |
| V3     | 4500    | 7.0            | Moderate         | Good          | 150          | 3                           |
| V4     | 6000    | 4.5            | Very Good        | Moderate      | 275          | 7                           |
| V5     | 5500    | 6.0            | Very Good        | Moderate      | 245          | 4                           |
Decision Matrix

Table 1.3

| Vendor | Weight (kg) | Defectives (%) | Quality (Rating) | Time (Rating) | Cost (Rs/kg) | Transportation Cost (Rs/kg) |
|--------|-------------|----------------|-----------------|--------------|-------------|-----------------------------|
| V1     | 5000        | 5.0            | 9               | 9            | 200         | 5                           |
| V2     | 3500        | 5.5            | 7               | 9            | 250         | 2                           |
| V3     | 4500        | 7.0            | 5               | 7            | 150         | 3                           |
| V4     | 6000        | 4.5            | 9               | 5            | 275         | 7                           |
| V5     | 5500        | 6.0            | 9               | 5            | 245         | 4                           |

N.M.

Table 1.4

| Vendor | Weight | Defectives | Quality | Time | Cost | Transportation Cost |
|--------|--------|------------|---------|------|------|---------------------|
| V1     | 0.4495 | 0.3947     | 0.5571  | 0.5571 | 0.3917 | 0.4927             |
| V2     | 0.3146 | 0.4341     | 0.4333  | 0.5571 | 0.4898 | 0.1917             |
| V3     | 0.4045 | 0.5525     | 0.3095  | 0.3095 | 0.2938 | 0.2956             |
| V4     | 0.5393 | 0.3552     | 0.5571  | 0.4333 | 0.5386 | 0.6897             |
| V5     | 0.4944 | 0.4736     | 0.4333  | 0.4333 | 0.4799 | 0.3941             |

Table 1.5

| S. No. | Weight (20%) | Defectives (25%) | Quality (30%) | Time (10%) | Cost (20%) | Transportation Cost (10%) |
|--------|--------------|-------------------|---------------|------------|------------|----------------------------|
| V1     | 0.0899       | 0.0987            | 0.1671        | 0.0557     | 0.0783     | 0.0493                     |
| V2     | 0.0692       | 0.1085            | 0.1299        | 0.0557     | 0.0974     | 0.0197                     |
| V3     | 0.0809       | 0.1381            | 0.0929        | 0.0433     | 0.0588     | 0.0296                     |
| V4     | 0.1076       | 0.0888            | 0.1671        | 0.0310     | 0.1077     | 0.0690                     |
| V5     | 0.0999       | 0.1184            | 0.1299        | 0.0310     | 0.0960     | 0.0394                     |

Ideal Solution

Negative Ideal Solution

Separation Measures

\[ S1^* = 0.0422 \quad S1^- = 0.0986 \]
\[ S2^* = 0.0571 \quad S2^- = 0.0827 \]
\[ S3^* = 0.0928 \quad S3^- = 0.0693 \]
\[ S4^* = 0.0697 \quad S4^- = 0.0891 \]
\[ S5^* = 0.0747 \quad S5^- = 0.0532 \]

Relative Closeness

\[ C1^* = 0.7003 \]
\[ C2^* = 0.5916 \]
\[ C3^* = 0.4275 \]
\[ C4^* = 0.5611 \]
\[ C5^* = 0.4159 \]
Vendor Order: V1, V2, V4, V3, V5

**SAW (Simple Additive Weighing)**

| Criteria         | Weight | P1  | P2  | P3  | P4  | P5  |
|------------------|--------|-----|-----|-----|-----|-----|
| Delivery         | 10     | 75  | 70  | 85  | 65  | 90  |
| Order            | 15     | 70  | 60  | 70  | 55  | 85  |
| Defectives       | 30     | 75  | 50  | 75  | 50  | 60  |
| Sales Price      | 30     | 70  | 75  | 60  | 75  | 75  |
| Transportation   | 15     | 60  | 70  | 75  | 65  | 80  |
| Weighted Score   | 100    | 70.5| 64  | 70.75| 62 | 74.25|

Product Order: P5, P3, P1, P2, P4

**TOPSIS METHOD**

| Product | Delivery (Rating) | Order (Quantity) | Defectives (%) | Sales Price (per piece) | Transportation Cost (Rs/Piece) |
|---------|-------------------|------------------|----------------|-------------------------|-------------------------------|
| P1      | Very Good         | 10,000           | 3.0            | 500                     | 5                             |
| P2      | Good              | 15,000           | 4.0            | 450                     | 9                             |
| P3      | Moderate          | 12,000           | 2.0            | 775                     | 6                             |
| P4      | Good              | 14,000           | 3.0            | 550                     | 8                             |
| P5      | Good              | 18,000           | 2.5            | 650                     | 7                             |

**Decision Matrix**

| Product | Delivery (Rating) | Order (Quantity) | Defectives (%) | Sales Price (per piece) | Transportation Cost (Rs/Piece) |
|---------|-------------------|------------------|----------------|-------------------------|-------------------------------|
| P1      | 9                 | 10,000           | 3.0            | 500                     | 5                             |
| P2      | 7                 | 15,000           | 4.0            | 450                     | 9                             |
| P3      | 5                 | 12,000           | 2.0            | 775                     | 6                             |
| P4      | 7                 | 14,000           | 3.0            | 550                     | 8                             |
| P5      | 7                 | 18,000           | 2.5            | 650                     | 7                             |

Normalized Matrix

Procedure is followed as above.

**Weightage Matrix**

| Product | Delivery (10%) | Order (20%) | Defectives (30%) | Sales Price (30%) | Transportation Cost (20%) |
|---------|----------------|-------------|------------------|-------------------|--------------------------|
| P1      | 0.0566         | 0.0636      | 0.1353           | 0.1127            | 0.0626                   |
| P2      | 0.0440         | 0.0954      | 0.1804           | 0.1013            | 0.1127                   |
| P3      | 0.0341         | 0.0637      | 0.0902           | 0.1744            | 0.0751                   |
| P4      | 0.0440         | 0.0890      | 0.1353           | 0.1236            | 0.1002                   |
| P5      | 0.0440         | 0.1145      | 0.1127           | 0.1463            | 0.0877                   |
Ideal Solution

Negative Ideal Solution

**Separation Measures**

\[
\begin{align*}
S1^* &= 0.0918 \\
S2^* &= 0.1285 \\
S3^* &= 0.0581 \\
S4^* &= 0.0827 \\
S5^* &= 0.0462
\end{align*}
\]

\[
\begin{align*}
S1 &= 0.0729 \\
S2 &= 0.0998 \\
S3 &= 0.0591 \\
S4 &= 0.0591 \\
S5 &= 0.0999
\end{align*}
\]

**Relative Closeness**

\[
\begin{align*}
C1^* &= 0.4426 \\
C2^* &= 0.4371 \\
C3^* &= 0.5043 \\
C4^* &= 0.4168 \\
C5^* &= 0.6838
\end{align*}
\]

**Customer Order:** C5, C3, C1, C2, C4

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**COMPANY 2**

**SAW (Simple Additive Weighing)**

| Criteria             | Weight | P1  | P2  | P3  | P4  |
|----------------------|--------|-----|-----|-----|-----|
| Cost                 | 40     | 45  | 90  | 80  | 30  |
| Defectives           | 30     | 50  | 95  | 80  | 60  |
| Availability of      | 30     | 85  | 70  | 85  | 50  |
| Raw Materials        |        |     |     |     |     |
| Weighted Score       | 100    | 58.5| 85.5| 81.5| 45  |

Product Order:- P2, P3, P1, P4

**TOPSIS METHOD**

| Product | Cost (Per Piece- Rs) | Defectives (%) | Availability of Raw Material (Rating) |
|---------|----------------------|----------------|---------------------------------------|
| P1      | 10                   | 5              | Very High                              |
| P2      | 13                   | 3              | High                                  |
| P3      | 12                   | 4              | Very High                              |
| P4      | 11                   | 4.5            | Average                               |
**Decision Matrix**

| Product | Cost (Per Piece- Rs) | Defectives (%) | Availability of Raw Material (Rating) |
|---------|----------------------|----------------|--------------------------------------|
| P1      | 10                   | 5              | 9                                    |
| P2      | 13                   | 3              | 7                                    |
| P3      | 12                   | 4              | 9                                    |
| P4      | 11                   | 4.5            | 5                                    |

**Normalized Matrix**

| Product | Cost (Per Piece- Rs) | Defectives (%) | Availability of Raw Material (Rating) |
|---------|----------------------|----------------|--------------------------------------|
| P1      | 0.4323               | 0.5965         | 0.5859                               |
| P2      | 0.5626               | 0.3579         | 0.4557                               |
| P3      | 0.5193               | 0.4772         | 0.5859                               |
| P4      | 0.4790               | 0.5369         | 0.3255                               |

**Weightage Matrix**

| Product | Cost (Per Piece- Rs) | Defectives (%) | Availability of Raw Material (Rating) |
|---------|----------------------|----------------|--------------------------------------|
| P1      | 0.1729               | 0.1789         | 0.1758                               |
| P2      | 0.2550               | 0.1074         | 0.1367                               |
| P3      | 0.2077               | 0.1432         | 0.1758                               |
| P4      | 0.1916               | 0.1611         | 0.0977                               |

**Ideal Solution**

**Negative Ideal Solution**

**Separation Measures**

- $S_1^* = 0.1089$
- $S_2^* = 0.0391$
- $S_3^* = 0.0593$
- $S_4^* = 0.1116$
- $S_1^- = 0.0781$
- $S_2^- = 0.1156$
- $S_3^- = 0.0927$
- $S_4^- = 0.0292$

**Relative Closeness**

- $C_1^* = 0.4176$
- $C_2^* = 0.7473$
- $C_3^* = 0.6098$
- $C_4^* = 0.2074$

**Product Order:** P2, P3, P1, P4
7. Conclusion

From the above mentioned calculations and results these are the following conclusions:

It is observed for company 1 that by considering various attributes like weight, defectives, quality, time, cost and transportation cost vendor V1 is the best vendor considering both SAW and TOPSIS. SAW emphasis on weightage of criteria while TOPSIS focuses on its distance from ideal solution as well, hence giving the comparative results between vendors. Similarly for products, product P5 has best rating according to both the techniques.

It can also be depicted for company 2 that considering cost, defectives and availability of raw materials as attributes, product P2 is the best rated product amongst the four choices on application of both TOPSIS and SAW. So it is recommended to company selecting any parameter like vendor or product after optimization.

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