Analyzing the Performance of Supply Chain using Topsis

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Abstract: ***The paper seeks to evaluate various attributes of Supply chain by means of some facts and figures and with the help of AHP and Topsis finally the performance index are calculated which provides a better picture of the various parameters their effect on the supply chain mathematically. Thus it provides a benchmark for a process and the managers to evaluate the performance and thus the efficacy with which it is performing by evaluating the effectiveness of the supply chain with the help of various parameters which are associated while performance is measured. A proper amalgamation of diverse factors such as financial, non-financial factors was taken into consideration by surveying including diverse variety of resources so available.***

Keywords: SCM, Performance Index, TOPSIS, SCM parameters.

1. Introduction

Performance measurement[1] has been one of the most important characteristics for any organization and the same is very essential to check the various aspects to analyze[5] of the process which either contributes to deliver the good performance or else it hampers the same involves a lot many factors a few of them are discussed here and it is also important in what extent does they affect so it involved such a process such as topsis[4] which not only helps in calculating the performance indices[3] one by one but also makes it easier for the managers to rank the attributes in a much precise and accurate manner. The process involves the necessity to evaluate so as to judge the performance [2] without which it becomes very difficult so as to keep a check on the parameters simultaneously. Hence it proves as an important tool for making decision and also to keep a track of all the factors and thus can be subjected to further improvement in case it requires so. The evaluation of various parameters[3],[11] of SCM by means of TOPSIS[9] provides a clear picture of the performance attributes, their effects mathematically as a result it saves time and the various trade-off which might be involved while performing the same task manually using some other approaches. Topsis[8] also facilitates us with the ranking[6] of the various parameters based on the values of the various parameters respectively. The performance includes not only the financial parameters [7] but also non-financial factors [3] for the managers to take the decision hence it contributes to the overall holistic approach to judge the various aspects of the SCM and thus the loopholes can be easily recognized based on that. The performance index provides with a clear view to review the performance of the various attributes of the SCM in a much clearer manner. The performance helps in evaluating the various aspects of the process which are the key features which are contributing for the better performance [7] which are less performing which are well evidenced by the performance index so calculated by the different process such as AHP, Topsis[5] , and finally it makes easier for the managers to take the decision by the numerical data so available.

2. Literature Review

Performance measurement has been considered as an important subject of consideration for a lot of different aspects for an overall progress of any firm as a result different methods were used to evaluate the same. A balanced score card [12] which included financial as well as various non-financial factors to keep a check on the same. Topsis[9], AHP[6] etc such process were also used for the same judgment factor while some of them involved multiple criteria and the overall performance evaluator. The most popular amongst them was a performance metrics evaluator which evaluated the performance across certain such index [3] to perform the task of carrying out the performance of the entire process. A scrutinized study was used which included journals and reviews[2] from different domains including various management journals too for better approach and knowledge of the methodology adopted while evaluating the performance index. A framework[1] is used to establish relationship between various aspects of the SC while various other process were used such as an integrated approach[3] was used to evaluate and check the SC performance by evaluating the performance indices[3] of the various parameters. Topsis [4], [8], [9], [5] was used as an important tool which suggested a path to perform the task in an easier manner and one which produces the output mathematically and precisely.

3. Previous work

While dealing with the same issues in the real time problem survey methods [11] were utilized while evaluating the performance of the operational parameters

[11] of the SCM in addition to the FUZZY implementation [4] approach too. Related approach was used in TOPSIS [9] approach based on centroid-index ranking method [8]. TOPSIS and MCGP [10] approach was used in same way as the paper seeks to evaluated the performance indices of the various parameters associated with the SCM process. Integrated approach suggested the use of weighted swings [3] method to calculate the performance indices some of them used Topsis in ranking and selecting various relevant features those which contribute to the performance of SCM directly or indirectly. Some of them also included financial factors [7], [3] as the factors which includes or contributes to the performance of the SCM. Topsis[5] and AHP[6] were few important tools which were used to make the task easier in previous papers.

4. Method Used

The paper implements Topsis as an important tool to evaluate the performance indices [3] of the SCM process and hence the performance. Firstly data is gathered from a manufacturing company based which provides as a reference to deal with the various aspects which are to be taken into consideration while evaluating the performance. The study provides basic information to implement Topsis [8] and hence makes the task in a real time world. Topsis follows certain algorithmic approach to follow the mathematical calculations which are summarized as:

Step 1. The first step is the formation of the Normalization Matrix [4] using all the values for the attributes which are depicted in the Table3.

Step2. Next step is the calculation of the Weighted Normalization Matrix [5] as shown and evidenced by the Table4.

Step3. Followed by the calculation of the weighted Normalization Matrix next step is to calculate the uppermost and the lowermost values which indicate the minimum and the maximum of the two values which are designated as most positive and most negative values. It is calculated using [5] as shown by equation 1:

$$\mathbf{A} = [a_{ij}]_{n\times m},\ a_{ij} = X'_{ij}/\sqrt{\sum_{i=1}^{n}(X'_{ij})^2} \quad i = 1, 2\ldots, n; \quad j = 1, 2\ldots$$

The same is shown in the Table5.

Step4. Next step is the separation measures calculations which are the deviations of the values from weighted Normalization Matrix. The values are calculated for each and every parameter that is seven different values are obtained for seven different attributes. It is calculated using [5] as shown by equation 2:

$$D_i^+ = \sqrt{\sum_{j=1}^{m} W_j(a_{ij}^+ - a_{ij})^2}$$

,

$$D_i^- = \sqrt{\sum_{j=1}^{m} W_j(a_{ij}^- - a_{ij})^2}$$

2.

The same is shown by the Table6.

Step6. Finally the performance index is calculated using the formulae [5] as shown by equation 3:

Based on the performance index one can easily figure out the overall performance of the various parameters accordingly with respect to the other.

Following table explains the various SCM parameters and the steps which are involved in TOPSIS which were studied in table1 The following section illustrates the above working methodology with the help of a case study and evaluates the performance [1] of the supply chain based on several factors merged together., The SCM performance can basically be divided into reliability, agility, responsiveness, costs and assets. The following factors were evaluated which are shown in the table1. The data was obtained while surveying [11] for the various SCM parameters which are again depicted in the table2. The table relates the various SCM parameters and the study helps us in evaluating the performance of the supply chain. The various parameters such as ODF: Order Delivery and Fulfillment , TTFO : Time To Fulfill order , USCMF : Upside SCM flexibility[3], SCMC : SCM cost[3] , COGS : Cost of goods sold[7] , ROWC : Return on Working Capital[7] , ROSCFA : Return on SC fixed assets[3]. The various parameters are inserted into a tabular format and the values are calculated using AHP. The process is followed by Topsis which finally calculates the performance index of the SCM. The case study is formulated in such a manner in such a way that the whole process is divided into seven different cycles and the performance is judged based on the performance of each parameter in each cycle and their individual formats too. The performance index is calculated for each parameter which is a better indicator of the performance judgment. The steps are followed as mentioned before the same procedure is followed in Topsis for evaluating the end result of performance indices [3]. All the steps are shown in the tables. The case study follows a seven cycle process which reveals the performance judgment of the whole SCM process and it also provides a better decision making analysis on the basis of the mathematical calculations and raw facts and figures it provides a direct and rational results which are less prone to errors but also satisfactory.

Table1. Parameters of SCM

Metric	*Meaning*	*Definition*
ODF	Order Delivery and Fulfillment	% of order meeting delivery Performance.
TTFO	Time To Fulfill order	Average actual time required to fulfill customer's order.
USCMF	Upside SCM flexibility	Average actual time required to fulfill customer's order.
SCMC	SCM cost	Sum of all costs associated with the SCM practices.
COGS	Cost of goods sold	Cost associated with purchase of goods raw materials etc.
ROWC	Return on Working Capital	Revenue generated w.r.t investment
ROSCFA	Return on SC fixed assets	Revenue generated w.r.t SC fixed assets

Table2. Showing the values for different parameters across different cycles

Metric Name	*Cycle1*	*Cycle2*	*Cycle3*	*Cycle4*	*Cycle5*	*Cycle 6*	*Cycle7*
ODF(in %)	82%	77.2 %	68%	93.2 %	94.7 %	95 %	90.2 %
TTFO(in days)	2.6	3	5.5	1.2	1.5	2.2	2.6
USCMF(days)	11	15	13	15.3	14.2	14.4	14.8
SCMC(%)	19.2 %	19%	19.1 %	19.4 %	19.3 %	19.4 %	19.4 %
COGS(%)	60%	63%	59.8 %	63.4 %	66.6 %	65.7 %	65.6 %
ROWC(%)	7%	6.2 %	6.3 %	6.7 %	6.3 %	6.8 %	7.5 %
ROSCFA (%)	4.4 %	4.5 %	4.9 %	4.5 %	3.3 %	3.6 %	3.9 %

Table2.1 Weights for different SCM attributes calculated using AHP

ODF	*TTFO*	*USCMF*	*SCMC*	*COGS*	*ROWC*	*ROSCFA*
0.1418	0.1861	0.0914	0.1429	0.1612	0.1386	0.1382

Table3. Conversion into Normalization Matrix for Topsis based on data inserted in Table2

ODF	*TTFO*	*USCMF*	*SCMC*	*COGS*	*ROWC*	*ROSCFA*
0.3596	0.3333	0.2760	0.3768	0.3598	0.3590	0.3971
0.3380	0.3846	0.3760	0.3729	0.3772	0.3498	0.4061
0.2980	0.7051	0.3266	0.3748	0.3588	0.3555	0.4422
0.4300	0.1538	0.3844	0.3807	0.3796	0.3781	0.4061
0.4150	0.1932	0.3567	0.3788	0.3988	0.3555	0.2978
0.4166	0.2820	0.3618	0.3807	0.3934	0.3837	0.3249
0.3956	0.3333	0.3718	0.3807	0.3928	0.4232	0.3519

Table4. Conversion into Weighted Normalization Matrix

ODF	*TTFO*	*USCMF*	*SCMC*	*COGS*	*ROWC*	*ROSCFA*
0.0509	0.0620	0.0252	0.0538	0.0579	0.0547	0.0548
0.0479	0.0715	0.0343	0.0532	0.0608	0.0484	0.0561
0.0422	0.1312	0.0298	0.0535	0.0578	0.0492	0.0611
0.0609	0.0286	0.0286	0.0544	0.0611	0.0524	0.0561
0.0588	0.0359	0.0326	0.0541	0.0642	0.0492	0.0411
0.0590	0.0524	0.0330	0.0544	0.0634	0.0531	0.0449
0.0560	0.0620	0.0339	0.0544	0.0633	0.0586	0.0486

Table5. Uppermost and Lowermost values after Weighted Normalization Matrix

	ODF	*TTFO*	*USCMF*	*SCMC*	*COGS*	*ROWC*	*ROSCFA*
Maximum	0.0609	0.1312	0.0343	0.0544	0.0642	0.0586	0.0611
Minimum	0.0422	0.0286	0.0252	0.0532	0.0578	0.0484	0.0411

Table6. Calculated Separation Measures for different parameters

ODF	*S1+*	*0.0053*	*S1-*	*0.000187*
TTFO	S2+	0.0084	S2-	0.002189
USCMF	S3+	0.0050	S3-	0.010900
SCMC	S4+	0.0106	S4-	0.000614
COGS	S5+	0.0957	S5-	0.000425
ROWC	S6+	0.0660	S6-	0.000985
ROSCFA	S7+	0.0496	S7-	0.000157

Table7. Showing the performance index of the attributes using the P.I = Si-/ (Si - + Si+)

ODF	*TTFO*	*USCMF*	*SCMC*	*COGS*	*ROWC*	*ROSCFA*
0.0340	0.0511	0.1943	0.0548	0.0425	0.1298	0.2404

5. Results

The performance index so obtained clearly specifies various attributes and their contribution towards the performance of the SCM and thus helps managers as a reference in taking their decisions accordingly. A ranking chart can also be prepared based on the various mathematical figures so obtained. The results so obtained are almost in full accordance which is well evidenced by the earlier studies.

6. Conclusion

The process so implemented provides a lengthy but easy approach to the domain problem of SCM performance which is one of the most critical issues in the coming industries of today. The paper also laid special focus on various financial as well as non-financial factors which affects the SCM performance. The overall catalogue is thus prepared and all the essential factors are included keeping in mind the one which were most important. The factors which hamper the performance are thus clearly

visible and t hence they are subjected for further improvements and proper check is to be made for them.

7. Future Scope

SCM is a vast area and is open for further research so it's performance analysis find a variety of applications and there are various other factors can also be added though full precautions was being taken while considering the parameters. Still some other factors may be taken (though they may not affect the overall performance) but to study the process well some more attributes can be taken into consideration. Additionally some other newer approaches software study can make the task easier. Further quality and performance go hand in hand few domains of quality can also be scrutinized for the same. Though some financial factors are included but some more factors which are relevance for the SCM measurement can also be taken. While surveying all the possible framework of studies can be evaluated for getting better results and more appropriate outcomes.

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