International Journal of Industrial Engineering & Production Research March 2021 Vol. 32, No. 1: 65-77
DOI: 10.22068/ijiepr.32.1.65

RESEARCH PAPER

Optimistic Implementation of Supply Chain Management in Small & Medium Enterprise: Approach using Grey Relational Analysis (GRA)

Mangesh Phate[1]*, Shraddha Toney[2] & Vikas Phate[3]

Received 11 December 2019; Revised 17 October 2020; Accepted 1 November 2020;

ABSTRACT

Supply chain management (SCM) is very well known efficient and effective managerial tool to check and analyze the performance of any enterprises. In the present work, efforts have taken to analyze and optimize the performance of small & medium enterprise (SME) in Pune region India. For this purpose a SCM based framework is prepared to get the realistic data from the industries through the questionnaire prepared on the basic of literature and the expert opinions. After finalizing the effective framework fitted to the various enterprises, a data in the pointer scale has been collected from the various stakeholders of the enterprises. The grey relational analysis (GRA), a multi-response optimization tool has been effectively used for getting the optimize result which will help the enterprises to plan the strategies for the betterment of the enterprises. Optimum results were implemented in the other enterprises. The responses were measured and compare with the optimum solution. From the responses, it has been observed that there is a significant enhancement in the response level of the other enterprises. Thus the SCM was effectively used for enhancing the performance of the SMEs in the region.

KEYWORDS: *Grey relational analysis; Grey relational grade; Optimization; Performance; Supply chain management; Small and Medium enterprise.*

Abbreviations: *SMEs; small and medium enterprise; GRA; grey relational analysis; GRG; grey relational grade; SCM; supply chain management.*

1. Introduction

Supply chain management (SCM) is very successful and competent tool to analysis the performance of an enterprise. In the recent year, worldwide researchers mainly focused on the effective use of SCM framework and decide the future strategies for the betterment of the enterprise. Today there is a need of effectual and competent way of analyzing the present performance and decide the future plan to survive in the global market and competition. For that purpose supply chain management (SCM) has been effectively. But the traditional way and tools used for its effective implementation is not fulfilled the current competitive industrial requirement. Hence deciding a optimize SCMs framework is a challenging task before its implementation. A supply chain is a framework consists of the available facilities, supplies, customers, and products, methods of controlling inventory, purchasing and distribution process adopted in the enterprises. It begins with the production of raw material by a supplier, and ends with the consumption of a product by the customer. In a supply chain, the flow of goods between a supplier and customer passes through several stages, and each stage may consist of many facilities. In the present days, deciding the effective supply chain network has been gaining importance due to increasing competitiveness introduced by the market globalization. Firms are obliged to maintain high customer service levels while at the same time they are forced to reduce cost and maintain profit margins. Traditionally,

* **Corresponding author:** ***Mangesh Phate***
mangeshphate03@gmail.com

1. *PhD All india Shri Shivaji, memorial Society's, College of Engineering, Pune, Maharashtra, India.*
2. *ME STES,Sinhgad Institute of TEchnology and Science, Pune, Maharashtra, India.*
3. *ME Government Polytechnic, Murtizapur, Maharashtra, India.*

marketing, distribution, planning, manufacturing, and purchasing organizations along the supply chain operated independently. These organizations have their own objectives and these are often conflicting. But, there is a need for a mechanism through which these different functions can be integrated together. The research will try to optimize the use of SCM in the small and medium scale enterprises in the Pune region, Maharashtra, India. The efforts have been taken to optimize the responses of the SCM for deciding the strategies for the development of SMEs.

2. Litrature Review

In the section a critical review related to the SCM's tools, application and the statistical techniques used by the researchers is discussed in brief.

Asl-Najafi J et al.[1] has effectively implemented a Bi-Level Closed-Loop Supply Chain considering Economic and Green Transportation Modes. The author focused on the coordinated decision making framework for the supply chain management. Two echelon closed –loop supply chain consisting of a manufacturing and retailer is examined in which manufacturer acts as a Stackelberg leader and the retailer acts as follower role. A various transportation activities between these two channels were carried out for the two models with centralized and the decentralized way. A generalized mathematical model for the live data has been formulated for the effective and efficient use of SCM tools and techniques for the betterment of the industries. Makui A et al [2] has critically studied the equilibrium for the component procurement strategies of two OEMs. They analyzed the strategies for two contracting power schemes in the supply chain. Here the supplier was worked as a Stackelberg leader. Fu Jai et al. [3] has presented the SCM analysis for the Multi-tier Sustainable supply chain management system. They designed the multi-tier supply chain of three MNCs to analyze the proactive sustainability projects in China. They designed the frame work for the effective leadership, governess and the efficient learning of the system. Bayatloo F. et al. [4] has effectively implemented SCM tool for the two-Stage Chance-Constraint Stochastic programming model for electricity supply chain network design. The used network consists of power stations, transmission lines, substations and the demand points. The objectives of their research are to maximize the effectiveness of the grid and minimizing the cost along with the capacity planning of the available facilities.

Bruno S.Silvestre et al. [5] have presented the d the challenges and remedies related to the sustainable supply chain management when the stakeholder collaboration becomes conductive to corruption. They exposed the antecedents, dynamics and consequences of corruption in the Brazilian beef supply chain. Philipp S. Sauer, Stefan Seuring [6] has presented the interaction of the literature related to the sustainable aspect in supply chain management (SC) and supply chain management (SSCM). Aniket et al. [7] has presented the way of handling a large sata using the concept of Big data in the supply chain Management. This paper identified the issues regarding SCM by the use of Delphi technique and tried to resolve these issues by the concept of Big Data. The author introduced a novel approach of Big data to analyze the SCM framework. Asare, E.N., Prempeh, K.B [8] has presented the methodology which will help the others to use SCM in supply chain of large enterprises (LES), SMEs increasingly have major influences on supply chain performance and could facilitate the roles of dealers, distributors, manufacturers and eventually consumers. The underlying motive of SCM is to accomplish a balance between the intention of increased quality service to the customers and reduced inventory and as well unit cost. Supply chain strategies are believed to be the important tool to contemporary business. There are seven important aspect of supply chain practice, which include established vision and objectives, information sharing, stake and reward sharing, collaboration, process incorporation, long-standing relationship and approved supply chain leadership. SMEs, as a result of their different limitations such as finance, groundwork, human resource management amongst others — have noticed it difficult to implement contemporary SCM into their tactical ambience.

Hamed Shakerian et al. [9] has analyzed that the knowledge management (KM) is the faster tool and more successful in the competitive market. But on the other hand, the importance of competition between the various companies has been lost. They observed that the KM provides the conceptual framework for implementing the SCM effectively. Harjeet Singh et al . [10] has critically observed that there is a limit in SCM to handle the extracted and intricate data. So they effectively used the the concept of big date is the SCM. The use of big data approach helped them to handle the large quantity data on disc and also

process effectively. Ying Yu et al [2016] has studies the effective and efficient use of E-commerce logistics in SCMs. The author presented the importance and effectiveness of E commerce tool integrated with SCM. Baymout et al [12] has analyzed the effective use of SCM and SMEs as a method that serves the organization to perform in a more active and lucrative manner by incorporating the methods of different partners at all the three important stages, that are, strategic, tactical, and operational. The three levels of SCM in SMEs are supply chain integration, planning and execution. Critical factor to the successful implementation of SCM in SMEs include: value, risk, methodology and visibility in the whole supply network. Strategic sourcing management acts along with dealers to persuade them to reveal their costs and its structures observed by the Khaseke et al [13,14]. SK Bhor & Dr. RR Gawande [15] has examined that the research trend in optimization of SCM is rising. The techniques like SCM, advanced optimization techniques, computing hardware, supporting complex and heavy data handling are being used since last 2 to 3 decades. Hence, there is enough potential and scope to carry out research in this field. They also observed that the developing countries are equally contributing in research related activities alike developed countries. It is a need of globalization to enhance research activities in the field of optimization in SCM in the developing countries. The following section in related to the SCM framework structured for the effective analysis of SME in the identified industries. Mangesh et.al [16,17] has used dimensional analysis and artificial neural network (ANN) and fuzzy grey relational analysis (GRA) as a multiresposne optimization tool in his research effectively and efficiently. Hence GRA is used in the presented work.

R. R. Gawande et al.[18-20] research aims at understanding role of information technology vis-à-vis SCM strategies adopted by different industrial sectors. The advantages of information technology in fulfilling various objectives of SCM strategies are discussed by them. The companies should consider all available options and should employ the most appropriate option in making choices regarding making investments in information technology adoption.

3. Supply Chain Framework Adopted

The SCM framework structured for the effective analysis of SME in the Pune regions in India is presented in the Fig1. From the literature review and the expert opinion, the following criteria and sub criteria has been selected as shown in table 1. The hypothesis made before the actual work are as follows:

- ✓ **Hypothesis 1 :**

Null Hypothesis: Procurement management is not a supply chain management practices followed in SME's.

Alternative Hypothesis: Procurement management is a supply chain management practices followed in SME's

- ✓ **Hypothesis 2:**

Null Hypothesis: Logistics management is not a supply chain management practices followed in SME's

Alternative Hypothesis: Logistics management is a supply chain management practices followed in SME's

- ✓ **Hypothesis 3:**

Null Hypothesis: Inventory management is not a supply chain management practices followed in SME's

Alternative Hypothesis: Inventory management is a supply chain management practices followed in SME's

- ✓ **Hypothesis 4:**

Hypothesis: Management of inflow structure is not a supply chain management practices followed in SME's

Alternative Hypothesis: Management of inflow structure is a supply chain management practices followed in SME's

- ✓ **Hypothesis 5:**

Null Hypothesis: Distribution management is not a supply chain management practices followed in SME's

Alternative Hypothesis: Distribution management is a supply chain management practices followed in SME's.

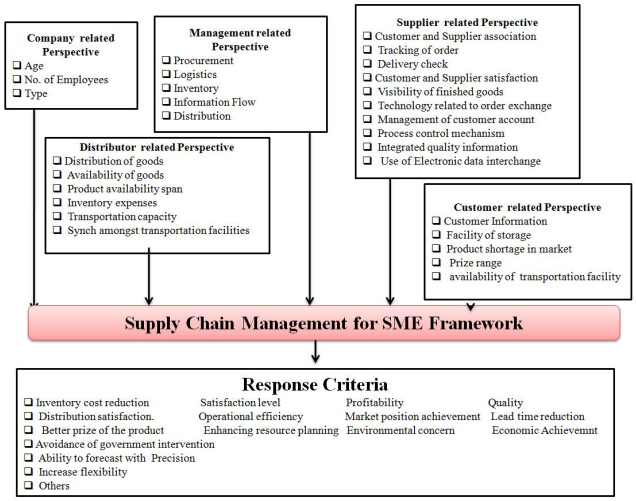

Fig. 1. Framework for implementation of SCM in SMEs.

The various criteria's used for getting the stakeholders opinion in the form of input and the response in the form of SCM effeteness small and medium scale enterprise is as shown in table 2. The cluster of following type of industries is used for the SCM data collection is as listed below.

Tab. 1. List of criteria used in SCM framework for collecting the input data.

Input Attributes	Sub Attributes
Company Details	Age (A1) No of Employee(A2) Type(A3)
Part 2 - Broad division of SCM practices from management's perspective	Procurement Management (B1) Logistics Management (B2) Inventory Management(B3) Management of Information Flow Structure (B4) Distribution Management (B5)
Part 4 B- SCM practices from the perspective of the supplier	Association between customers and suppliers (C1) Tracking all purchase order information (C2) Quality checks And tracking of delivery (C3) Measures for satisfaction of Supplier/Customer(C4) Visibility of Finished goods (C5) Technology of taking and entering orders. (C6)
Part 4 B- SCM practices from the perspective of the distributor	Dispersal of timely and accurate information to the customers (E1) Providing the facility of storage. (E2) Avoidance of product shortage in the market at all times. (E3) Lowest price levels being offered to the customers in the industry. (E4) Provision of transportation facilities (E5)

Tab. 2. List of response criteria used in SCM framework for SME performance analysis.

Response Attributes	Response Attributes
Reduction of Inventory carrying costs and overhead expenses (R1)	Better pricing of products (R9)
Increased satisfaction level of the final customer (R2)	Enhanced resource planning (R10)
Increased profitability (R3)	Acknowledgement of environmental concerns (R11)
Better quality and quantity information. (R4)	Achieving economies of scale (R12)
Satisfaction of the requests of the distributor and the customer. (R5)	Avoidance of government intervention and tax implications(R13)
Increased operational efficiency (R6)	Ability to forecast with precision (R14)
Achievement of a strategic market position (R7)	Increased flexibility in routing, production and scheduling (R15)
Reduction of lead time in procurement (R8)	Others (R16)

- Logistics & Transportation
- Cars and automotive parts
- Metal products and machines
- Electronics
- Clothing and textiles
- Health care and pharmaceutical products Services
- Agricultural production
- Food processing industry
- Furniture manufacturing
- Plastics and chemistry
- Construction and construction products
- Wholesale and retail trade
- Others

The questionnaire is prepare based on the above criteria's and data has been collected from 320 various stakeholders of the above listed industries. The response is scaled in the pointer of 1-5 as shown in table 3. After collecting the large data. From the table 4, we conclude that out of 320 respondent, 18.8% are less than 1 year, 61.3% are 1 – 5 years, 16.9 % are 5 – 10 years, 1.3% are 10 – 15 years and 1.9% are more than 15 years of age of business since registration.

Tab. 3. Pointer scale used for collecting the data of various stakeholders input.

Pointer scale	Management's and distributors perspectives	Customer perspectives	Response for the benefits of SCM
1	Excellent	Strongly agree	Very unimportant
2	Good	agree	Unimportant
3	Indifferent	Neutral	Neutral
4	Poor	disagree	Important
5	Very Poor	Strongly disagree	Very important

Tab. 4. Age of business from the date of registration.

Age (yr)	Freq.	%	Valid %	Cumulative %
< 1	60	18.8	18.8	18.8
1-5	196	61.3	61.3	80.0
5-10	54	16.9	16.9	96.9
10-15	4	1.3	1.3	98.1
>15	6	1.9	1.9	100
Total	320	100	100	

From the table 5 we conclude that out of 320 respondent, 25.0% have less than 2 (self-employed), 43.1% have 2 – 9 (micro enterprise), 23.4% have 10 – 49 (small Scale enterprise) and 50 – 249 (medium scale enterprise). It is also represented in pie chart.

Tab. 5. Nos. of employees and type of enterprise

Age (yr)	Freq.	%	Valid %	Cumu. %
< 2	80	25.00	25.00	25.00
2-9	138	43.10	43.10	68.1
10-49	75	23.4	23.4	91.6
50-249	27	8.4	8.4	100
Total	320	100	100	

The nature of the SME and the stakeholders is as shown in the above section. From the various respondent listed above, the data in the form of answered questionnaire has been prepared in the rigorous way. After collecting the data, the next step is to optimize the performance parameters of the enterprises consider for the investigation. Total sixteen responses are identified as a performance indicator. The list of these is as shown in table 2. The scale data of the responses are collected from the various stakeholders. The presented work is focused on the optimization of the various response parameters which will help the SMEs to decide the strategies to sustain the changing market completion. For that purpose an effective multi-response technique called grey relational analysis (GRA) is used in the presented work. The basic methodology of GRA is very effective and use for various managerial decisions [21-24] discussed in the next section.

4. Grey Relational Analysis (GRA)

Grey relational analysis (GRA) of grey theory is a technique to analyze degrees of associations among discrete sequence data. It does quantitative comparative analysis of the development trend of grey system factors. Grey relational analysis measures the relational degrees according to the similar or different degrees of development trends. It represents every relationship among factors regarding systems one by one as system decisions, providing available information and more consistent basis. This kind of analysis model can clearly illuminate the grey relations among factors in a grey system and it is a degree to quantify a change trend of a system. GRA is useful in deciding strategies with uncertain information. In GRA the obtain result are based upon the original data and the calculations are very easy to understand and implement. It is one of the best methods to help the management to make the decision under the competitive business environment. Hence GRA is used as multi-response tool in the presented work.

The Grey relational analysis (GRA) is the multi response optimization approach applied to find out the best set of input parameters for determining the optimum conditions of various input parameters. The following steps are involved in the GRA approach. Fig 2 shows the GRA model used to perform the multi-resposne optimization.

4.1. Normalization of the raw data

The first step in the GRA is to normalize the data in the range of 0.00 to 1.00. In this step, the collected realistic data is converted in to the scale of 0 to 1. The response criteria are classified into two types i.e. maximization and minimization. As the objectives of all the response criteria are of maximization, Higher-the better" approach of optimization is used. To normalize the maximize response following Equation 1 is used.

$$X_i^*(j) = \frac{X_i^k(j) - \text{Min}\, X_i^k(j)}{\text{Max}\, X_i^k(j) - \text{Min} X_i^k(j)} \quad (1)$$

Where $X_i^k(j)$ is the original sequence, $X_i^*(j)$ is the sequence after data pre-processing, $\text{Min}\, X_i^k(j)$ is the minimum value of $X_i^k(j)$ and $\text{Max}\, X_i^k(j)$ is the maximum value of $X_i^k(j)$.

4.2. Calculate coefficient of grey relational grade (GRA)

The next step after the data normalization is to find out the Grey relational coefficient. To find out the deviation sequence, first find out the maximum value of the normalized data sequence. Let "M" is the maximum value which is known as the reference value. The maximum value "Ymax" is given by the following Equation 2.

$$Ymax = \max(X_{ijk}) \quad (2)$$

4.3. Calculation for deviational sequence (∂_{ijk}) :

The deviation is the difference between normalized sequence vale and the reference value (Ymax). This is given by the Equation 3.

$$\partial_{ijk} = X_{ijk} - Ymax \quad (3)$$

4.4. Calculation for grey relational coefficient:

The grey relational coefficient is given by the following Equation 4.

$$\varepsilon_i(k) = \frac{\partial_{\min} + \alpha\, \partial_{\max}}{\partial_{oi}(k) + \alpha\, \partial_{\max}} \quad (4)$$

Where $\partial_{oi}(k)$ is the deviation sequence of reference sequence which is given by the following Equation 5.

$$\partial_{oi}(k) = \left\| X_o^*(k) - X_i^{*O}(k) \right\| \quad (5)$$

$$\partial_{\max} = \max \max \left\| X_o^*(k) - X_j^{*O}(k) \right\| \quad (6)$$

$$\partial_{\max} = \min \min \left\| X_o^*(k) - X_j^{*O}(k) \right\| \quad (7)$$

Where "α" is the distinguishing coefficient. Generally It is 0.5 is being used i.e.α ϵ [0, 1].Grey relational grade is calculated by taking the mean of grey relational coefficient of all responses. The grey relational grade is given by the following Equation 8.

$$r_i = \frac{1}{n}\sum_{k=1}^{n} i\partial_i(k) \quad (8)$$

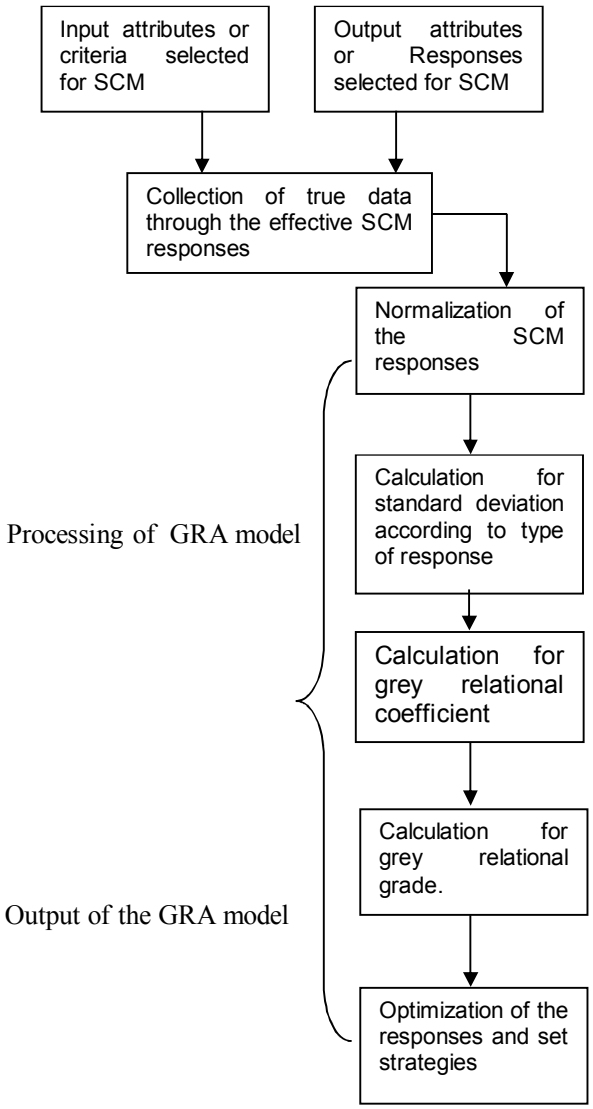

Fig. 2. GRA model implemented for optimization of SCM in SMEs

4.5. Selection of optimize strategies by SCM

In the section we have discussed about the formulation of a strong SCM framework, set a questionnaire for collecting the various stakeholder's responses in the pointed scale of 1-5 and the optimization of the SCM responses by using multiresponse. The results obtain are discussed in this section.

In the first step the realistic data is collected through the effective implementation of SCM design questionnaire . The input data is the response collected through the various stake holders opinion in the pointed as shown in table 2. The realistic responses variable is as shown in Table 6. After the collection of the realistic response data, the next step is to normalize the data using Equation 1. The normalized data in

the range 0-1 is as shown in table 7. After normalizing the data the next step is to find out the standard deviation sequence. The standard deviation sequence is obtain by using Equation 3. The normalized deviation sequence is obtain and tabulated in the table 8.

Tab. 6. Average response criteria's realistic sample data.

Obs. No	R1 (Criteria 1-5)	R2 (Criteria 6-10)	R3 (Criteria 11-16)
2	4	4	4.166666667
3	4.6	4	4.333333333
4	4.4	4.4	4.166666667
98	4	4	4.5
99	2	3.2	3.5
100	4.8	4.4	4.666666667
101	4.4	4.6	3.5
139	4.2	4.4	4.5
158	4.2	3.8	4.5
159	4.2	4.6	4.5
160	2.2	3.6	2.333333333
161	2.4	2	2.5
162	3.2	3.2	2.166666667
198	2.4	2.2	3.333333333
199	3.6	2.2	2.5
200	3.6	2	2.5
201	4.2	2.2	2.5
202	3.8	2.2	2.5
203	1.8	2.2	2
204	2.2	1.8	2.666666667
236	4	4.4	4.5
237	4.4	4	4.333333333
238	4.4	4.4	4.333333333
239	4.2	4.4	4.166666667
240	4.4	4.2	4.666666667
241	5	4.8	4.5
242	4.6	4.6	4.666666667
243	4.4	4.6	4.5
244	4.6	4.4	4.833333333
318	4.4	4	4.5
319	4.6	4.2	4
320	4	4	4

After getting the std deviation sequence , the next steps to find out the grey relational coefficient for the data obtain in the table 8. The grey relational coefficient is obtain using equation 4-7. The data is tabulated in the Table 9. The last and the most important step in the GRA are to find out the grey relational grade (GRG) for all the data response. The GRG will help to find out the optimized condition for the entire responses collected. The GRG is calculated by using Equation 8. The highest value in the scale of 0-1 is the optimum condition noted. From the above analysis, it has been cleared that the GRG with 0.94667 corresponding to the observation no 241 gives us the optimum set of input parameters. The values are as shown in table 9 & 10 respectively.

Tab. 7. Normalization of the data

Obs. No	R1 (Criteria 1-5)	R2 (Criteria 6-10)	R3 (Criteria 11-16)
2	0.705882353	0.733333333	0.809533333
3	0.882352941	0.733333333	0.857152381
4	0.823529412	0.866666667	0.809533333

98	0.705882353	0.733333333	0.904771429
99	0.117647059	0.466666667	0.619057143
100	0.941176471	0.866666667	0.952390476
101	0.823529412	0.933333333	0.619057143
139	0.764705882	0.866666667	0.904771429
158	0.764705882	0.666666667	0.904771429
159	0.764705882	0.933333333	0.904771429
160	0.176470588	0.6	0.28572381
161	0.235294118	0.066666667	0.333342857
162	0.470588235	0.466666667	0.238104762
198	0.235294118	0.133333333	0.571438095
199	0.588235294	0.133333333	0.333342857
200	0.588235294	0.066666667	0.333342857
201	0.764705882	0.133333333	0.333342857
202	0.647058824	0.133333333	0.333342857
203	0.058823529	0.133333333	0.190485714
204	0.176470588	0	0.380961905
236	0.705882353	0.866666667	0.904771429
237	0.823529412	0.733333333	0.857152381
238	0.823529412	0.866666667	0.857152381
239	0.764705882	0.866666667	0.809533333
240	0.823529412	0.8	0.952390476
241	1	1	0.904771429
242	0.882352941	0.933333333	0.952390476
243	0.823529412	0.933333333	0.904771429
244	0.882352941	0.866666667	1
318	0.823529412	0.733333333	0.904771429
319	0.882352941	0.8	0.761914286
320	0.705882353	0.733333333	0.761914286

The results obtain through the GRA analysis will help us to fixed the strategies which will help to improve the performance of SMEs in India. Table 11 shows the optimize strategies for the individual enterprise and the overall strategies for the enterprise consider for the investigation.

Tab. 8. Calculation of normalized deviation sequence of the data

Obs. No	R1 (Criteria 1-5)	R2 (Criteria 6-10)	R3 (Criteria 11-16)
2	0.294118	0.266667	0.190466667
3	0.117647	0.266667	0.142847619
4	0.176471	0.133333	0.190466667
98	0.294118	0.266667	0.095228571
99	0.882353	0.533333	0.380942857
100	0.058824	0.133333	0.047609524
101	0.176471	0.066667	0.380942857
139	0.235294	0.133333	0.095228571
158	0.235294	0.333333	0.095228571
159	0.235294	0.066667	0.095228571
160	0.823529	0.4	0.71427619
161	0.764706	0.933333	0.666657143
162	0.529412	0.533333	0.761895238
198	0.764706	0.866667	0.428561905

199	0.411765	0.866667	0.666657143
200	0.411765	0.933333	0.666657143
201	0.235294	0.866667	0.666657143
202	0.352941	0.866667	0.666657143
203	0.941176	0.866667	0.809514286
204	0.823529	1	0.619038095
236	0.294118	0.133333	0.095228571
237	0.176471	0.266667	0.142847619
238	0.176471	0.133333	0.142847619
239	0.235294	0.133333	0.190466667
240	0.176471	0.2	0.047609524
241	0	0	0.095228571
242	0.117647	0.066667	0.047609524
243	0.176471	0.066667	0.095228571
244	0.117647	0.133333	0
318	0.176471	0.266667	0.095228571
319	0.117647	0.2	0.238085714
320	0.294118	0.266667	0.238085714

The results obtain through the GRA analysis will help us to fixed the individual strategies to sustain in the global competitive market.

Tab. 9. Calculation of grey relational coefficient and grey relational grade

SN	R1 (Criteria 1-5)	R2 (Criteria 6-10)	R3 (Criteria 11-16)	Obs. No
2	0.62963	0.65217	0.72414	0.66865048
3	0.80952	0.65217	0.77778	0.74649567
4	0.73913	0.78947	0.72414	0.75091734
98	0.62963	0.65217	0.84001	0.70727232
99	0.36170	0.48387	0.56757	0.47104893
100	0.89473	0.78947	0.91305	0.86575662
101	0.73913	0.88235	0.5675	0.72968569
139	0.68	0.78947	0.84001	0.76982904
158	0.68	0.6	0.840013	0.70667114
159	0.68	0.882353	0.840013	0.80078879
160	0.37777	0.55555	0.41176	0.4483670
161	0.395349	0.348837	0.428575	0.390920325
162	0.485714	0.483871	0.396229	0.455271553
198	0.395349	0.365854	0.538467	0.433223186
199	0.548387	0.365854	0.428575	0.447605227
200	0.548387	0.348837	0.428575	0.441933078
201	0.68	0.365854	0.428575	0.491476195
202	0.586207	0.365854	0.428575	0.460211827
203	0.346939	0.365854	0.381821	0.364871131
204	0.377778	0.333333	0.446812	0.385974475
236	0.62963	0.789474	0.840013	0.753038918
237	0.73913	0.652174	0.777789	0.723031216
238	0.73913	0.789474	0.777789	0.768797807
239	0.68	0.789474	0.724148	0.731207201
240	0.73913	0.714286	0.913059	0.788825169

241	1	1	0.840013	0.946671147
242	0.809524	0.882353	0.913059	0.868312036
243	0.73913	0.882353	0.840013	0.820498939
244	0.809524	0.789474	1	0.866332498
318	0.73913	0.652174	0.840013	0.74377259
319	0.80952	0.71428	0.67742	0.73374587
320	0.62963	0.65217	0.67742	0.65307721

4.6. Validation of the optimized results

From the multiresposne optimization GRA analysis, it has been observed that the organization type 11 i.e. wholesale and retail trade has a highest value of grey relational grade (0.946671). Hence this organization has best strategies amongst all the organization consider in the presented work. For validating the optimization of the strategies, The reopens obtain from the various stake holders (as shown in table 11) is effectively implemented in the five other organization and the response after implementing the suggested strategies was noted. From the response obtain after implementation of optimized strategies, it has been observed that the SCM parameters were significantly improved which leads to the maximization of profit and the other response noted in table 12.

Tab. 10. Optimization of response parameters based on GRA for the various type of industry

S.n	Type of industry	GRG	Overall best GRG
1	Logistics & Transportation	0.8414079	
2	Cars and automotive parts	0.8053415	
3	Metal products and machines	0.820666	
4	Electronics	0.857388	
5	Clothing and textiles	0.865756	
6	Health care and pharmaceutical products Services	0.823222	0.946671
7	Agricultural production	0.800788	
8	Food processing industry	0.840693	
9	Furniture manufacturing	0.673781	
10	Plastics and chemistry	0.77723	
11	Construction and construction products	0.749087	
12	Wholesale and retail trade	0.946671	
13	Others	0.8683121	

5. Conclusion

The main objective of the present work was to optimize the small and medium scale enterprises performance in Pune, Maharashtra, India region. For that purpose response based on the questionnaire has been prepared and the data was collected for getting the exact ideas about the various stake holders view regarding the strategies used in the SMEs in this region. On the basic of 320 responses, a multiresposne optimization method called grey relational grade (GRA) was selected and implemented effectively and efficiently. The optimize result obtain through this analysis was send to the other industries and tried to implement the strategies accordingly. The responses after the implementation of optimize plan the ourput response were noted to check the performance of the industries. From the results, it is cleared that the responses are significantly changed for other industries. This will help to improve the performance of other industries. Hence SCM coupled with the GRA will help to plan the optimized strategies for the betterment of the SMEs in India.

6. Future Scope

Supply chain management is a very effective and efficient management tool used in the industries to improve the performance of the. The present work will help the industry to find out the favorable working conditions and the managerial

decision to improve the performance. The grey relational analysis (GRA) is employed for the multi-response optimization. The Integrated SCM and GRA approach can be used in other industries in the future for the betterment of the firm.

7. Acknowledgements

Author would express his thanks to all the stakeholders industries and the staff during the data collection.

Conflict of Interest: Authors has no conflict of interest.

References

[1] Najafi, A., Yaghoubi, S., Azaron, A. *Coordination of a Bi-Level Closed-Loop Supply Chain considering Economic and Green Transportation Modes*. Int. J. of Ind. and Prod.Res., Vol. 29, No.4, (2018), pp. 429-441.

[2] Makui, A., Soleimani M., *Bolandifar, E., Equilibrium for Procurement Strategy between Triad Competitive Supply Chains.*Int. J. of Ind. and Prod.Res; Vol. 29, No. 4, (2018), pp. 443-460.

[3] Fu Jai., Yu, Gong., Steve, Brown., Multi-tier Sustainable supply chain management : The role of Supply chain leadership. Int. J. of Pro. Ecos (2018).

[4] Bayatloo, F., Bozorgi-Amiri., A Two-Stage Chance-Constraint Stochastic Programming Model for Electricity Supply Chain Network Design. Int. J. of Ind. and Prod.Res. Vol. 29, No. 4, (2018), pp. 471-482.

[5] Bruno, S.,Silvestre, Marcelo, S., Fernando Luiz, E., Viana, Jose M., Sousa-Filho., Challenges for sustainable supply chain management: When stakeholder collaboration becomes conducive to corruption." J. Cleaner Prod.194: (2018), pp. 766-776.

[6] Philipp, S., Sauer, Stefan S., Sustainable supply chain management for minerals. J.of Cleaner Prod. Vol. 151, (2017), pp. 235-249.

[7] Anikit, D., Jain, I., Jishnu, M., Agrawal,S., Application of Big Data in Supply Chain management.Mat.Tech. Proc. Vol. 4, No. 2, (2017), pp. 1106-1115.

[8] Asare, N., Prempeh, B., The State of Supply Chain Management Practices within SMEs in Ghana: A Case Study of Selected Agrochemical Companies in Kumasi.2016,MPRA Publication, Paper No. 70181, (2016).

[9] Shakerian,H., Dehnav,H., Fatemeh,S., A Framework for the Implementation of knowledge Management in Supply Chain Management" Proc. –Soc.l and behavior Sci.,Vol. 230, (2016), pp. 176-183.

[10] Singh,H., Sunny, S., Integration of Spark framework in Supply Chain Management. Procedia of Computer Sciences, Vol. 79, (2016), pp. 1013-1020.

[11] Ying, Yu., Xin, Wang., Zhong,R., Georg,H., E –commerce Logistics in Supply Chain Management : Practice Perspective" Procidia, CIRP,Vol. 52, (2016), pp. 179-185.

[12] Baymout, M., Supply Chain Management for Small and Medium Size Enterprises." Int. J.of Advan. in Res. & Tech. Vol. 4, No. 5, (2015), pp. 20-35.

[13] Khaseke A.A., Global Supply Chain Management Practices and Performance of Toyota Kenya Limited", Master Thesis, University of Nairobi (2015).

[14] Thakkar,J.,Kanda,A., Deshmukh, S., Supply chain performance measurement framework for small and medium scale enterprises, Benchmarking:"An Int. J.l, Vol. 16, No. 5, (2014), pp. 702-723.

[15] Bhor,S., & Gawande,R., Review of Optimization of Supply Chain Management in SMEs." Int. J. of Adv. in Mant, Tech. & Eng.Sci.7(II), (2012).

[16] M. R. Phate ,S. B. Toney., "Modeling and prediction of WEDM performance parameters for Al/SiCp MMC using dimensional analysis and artificial neural network", Engineering Science and Technology, an International Journal.

[17] M. R. Phate, S. B. Toney, V.R.Phate. Analysis of Machining Parameters in WEDM of Al/SiCp20 MMC Using Taguchi-Based Grey-Fuzzy Approach", Hindawi Modelling and Simulation in

Engineering,Vol. 2019, Article ID 1483169 (2019).

[18] Gawande,R., Chopade, I.,and Hiwase,R., "Key Factors For Reliability and Validity Estimation of an Instrument for Assessing Operational Effectiveness of an Organization as a Function of Supply Chain management " Int. J. of Engg. Res. & Indu. Appls. Vol. 4, No. IV, pp. 69-82.

[19] Bhor,S., and Gawande,R., A Critical Review To Optimize The Effective Framework For Implementation Of Supply Chain Management In Small & Medium Enterprise" International Journal of Research and Analytical Reviews (IJRAR), Vol. 6, No. 1, (2019), pp. 1014-1022.

[20] Bhor, S., and Gawande, R., Survey and Analysis of Challenges and factors involved in Pune SMEs" Journal of Advanced Research in Dynamical and Controls Systems, Vol. 10, No. 13, (2013), pp. 1005-1010.

[21] Morteza, Y., Cengiz, K., Pascale, Z.,Sezi, C., A fuzzy multi attribute decision framework with integration of QFD and grey relational analysis.Expert Systems With Applications (2018).

[22] Rajesh, R., Ravi,V., Supplier selection in resilient supply chains: a grey relational analysis approach" Journal of Cleaner Production Vol. 86, (2015), pp. 343-359.

[23] R. Rajesh, Measuring the barriers to resilience in manufacturing supply chains using grey clustering and vikor approaches", Measurement (2018),: https://doi.org/10.1016/j.measurement.2018.05.043.

[24] Shojaei, P., Amin Seyed Haeri, S., Development of supply chain risk management approaches for construction projects: A grounded theory approach, Comp. & Ind. Eng, (2016), : doi: https://doi.org/10.1016/j.cie.2018.11.045.

Follow This Article at The Following Site:

Phate M, Toney S, Phate V. Optimistic Implementation of Supply Chain Management in Small & Medium Enterprise: Approach using Grey Relational Analysis (GRA). IJIEPR. 2021; 32 (1) :65-77
URL: http://ijiepr.iust.ac.ir/article-1-996-en.html