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Application of AHP and TOPSIS Method for Supplier Selection Between India & China in Textile Industry

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Abstract - *Supplier selection, the method of optimizing the appropriate suppliers who will be able to supply the buyer with the right quality products and/or services at the right price, at the right time and in the right quantities,. In other words, supplier selection is a multi-criteria decision making problem which includes both qualitative and quantitative factors. China and India are the top two textile producers in the world. The proceeds from textile and apparel exports have contributed greatly to the economic development of both countries. In order to choose the best suppliers, it is essential to make a trade-off between these tangible and intangible factors, some of which may conflict. The aim of this study is to develop a methodology to evaluate suppliers in supply chain cycle based on Technique for Order Preference by Similarity to Ideal Solution method(TOPSIS). In this paper, we have taken into consideration some important criteria which affect the process of supplier selection, that is, product quality, service quality, delivery time and price. We have calculated the weights for each criterion based on Analytic Hierarchy Process (AHP) and then inputted these weights to the TOPSIS method to rank suppliers. The entire methodology is illustrated with the help of a numerical example and finally the rank of each supplier is determined according to its results.*

Key Words: Analytic Hierarchy Process (AHP), multi-criteria decision making, supplier selection, Technique for Order Preference by Similarity to Ideal Solution method (TOPSIS).

1.INTRODUCTION

Supply Chain Management (SCM) is a process of organizing the activities from the customer's order through final delivery for speed, efficiency, and quality[1] . In supply chain one of the major factor is supplier . SCM has an increasing importance in today's competitive business world and companies need to have strong relationships and integrations with their suppliers for a successful SCM system. Supplier selection problem is a multiple criteria decision making (MCDM) problem typically having conflicting criteria that include both qualitative and quantitative measures. Due to strategic importance of supplier selection process, extensive research has been done on supplier selection criteria and methods.

China and India are the top two textile producers in the world .Various Textile Brands are available both in India & China. Interestingly, textile enterprises in China and India have adopted quite different business models and have followed divergent growth tracks. Since following different path it has it's own advantage & disadvantage . Based on advantage & disadvantage & various criteria if we have to choose either of one country which is MCDM problem we can adopt AHP-TOPSIS method . In this we have calculated the weights for each criterion and inputted those weights to the TOPSIS method to rank suppliers. The main advantages of using TOPSIS method are

1. It is simple to use.
2. It takes into account all types of criteria (subjective and objective).
3. It is rational and understandable.
4. The computation processes are straight forward.
5. The concept permits the pursuit of best alternatives criterion depicted in a simple mathematical calculation.

2.LITERATURE REVIEW

Emrah Onder et al(2013) used AHP TOPSIS for supplier selection for a well-known cable manufacturing company in Turkey. In these seven criteria's were used Origin of Raw Material , Quality , Availability , Cost , Delivery Requirements , Cost of Conveyance , Quality Certificates and Reliability of Supplier . In these he used consistency ratio to justify the opinion of experts. Soner Akkoç et al (2013) conducted a evaluation study of fuzzy performance using AHP & TOPSIS methods , conducting study in banking sector in Turkey. Study were conducted on the financial performance of twelve commercial banks & were evaluated in terms of seventeen financial performance indicators by employing Fuzzy Analytic Hierarchy Process (henceforth Fuzzy AHP) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (henceforth Fuzzy TOPSİS) methods & it was found that these two methods rank banks in a similar manner.. Bahar

Sennaroglu et al(2012) applied AHP TOPSIS in supplier selection for a voltage switching device .In this paper he use almost seven main criteria & twenty one sub criteria for supplier selection from alternatives (4) available & used a scale 1 to 9 for ranking. Pema Wangchen Bhutia et al (2012) described how to use AHP TOPSIS for supplier selection from a number of alternatives (30)using 4 main criterias . In also highlight the method AHP TOPSIS in simple form using a good example. Prince Agarwal et al (2011) reviewed sixty-eight articles from 2000 to 2011 to find out the most outstanding MCDM methodology followed by the researchers for supplier evaluation and selection. They report the distribution of MCDM methods used in these articles by DEA 30%, mathematical programming models 17%, Analytic Hierarchy Process (AHP) 15%, CBR 11%, Analytic Network Process (ANP) 5%, fuzzy set theory 10%, simple multi-attribute rating technique (SMART) 3%, genetic algorithm (GA) 2%, and criteria based decision making methods such as ELECTRE and PROMETHEE 7%.Ali Shemshadi et al (2011) used ANP along with FUZZY TOPSIS for supplier selection . In the proposed methodology ANP was used for comparison of criteria to get the normalized weight of each risk criteria (this part takes the impact factor of the risk into consideration). Then, using a fuzzy TOPSIS approach, he rank the alternatives based on the probability issue and the calculated weights of the criteria. Mohammad Saeed Zaeri et al(2011) utilized AHP TOPSIS in supplier selection by ranking criteria's as per the opinion of experts & finally the proposed methodology was illustrated with numerical example. Doraid Dalalah et al(2010) described how the AHP TOPSIS vary from knowledge (data) based system in crane selection . It was seen that AHP TOPSIS captures both subjective and objective assessment measures of the alternative options available, thus reducing bias in decision making . Here it was used three data based system against AHP .S. Datta et al (2009) used MCDM method to evaluate the guide for research .Using the methodology of COPRAS-G problem got solved ,In this sixteen key indicator were identified . Farzad Tahriri et al(2008) studied the trade off between tangible and intangible factors for proper supplier selection. It also carry different selection methods concerning supplier selection and studied in deep related to advantages and disadvantages of selection methods especially AHP TOPSIS. Chan et al. (2007) applied an AHP to determine the optimal supplier. His model evaluated the suppliers based on 14 criteria. Chiou et al. (2005) used a fuzzy hierarchical analytic process to determine the weights of criteria from subjective judgments and a non-additive integral technique to evaluate the performance of sustainable development strategies for aquatic products processors. . Lalit Mohan (2013) discussed how the Bangladesh & Indian textile vary ,what are the major reforms occurred in industry in year 1995-2003 . Study on export was done with Balassa's index of Revealed Comparative Advantage (RCA).And in final , products in which India and Bangladesh had comparative advantage in garment exports were highlighted.. Arvind Panagariya et al (2013) provided a comparison between India & China textile industry from the time of liberalization to financial crisis along with outlook of Indian textile industry to world . It also draw out future challenges in trade policy & put forward four suggestion to overcome these drawback.Stephen MacDonald et al (2013) studied the effect distribution channels on demand for apparel, home textiles, and other textiles (including shoes) in urban China. In the paper the categorization of customers into three ,based on literatures & also come to the utility tree . Wei Tian et al (2012) discussed & analyzed the pattern of China and India since 2000. It also examined the industrial policies of these two countries and posit that the key reason behind the different trade behavior of these two countries. Moriki et al (2009) conducted a comparative study of textile industry both in India & China. In these they select some important industries (in textile) & compare process development & try to figure out some casual factor which affect industry. Tim Lindgren et al (2009) studied the impact of Chinese textile industry into Australian Fashion industry .The methodology adopted was semi structured interview & it was found that Australia mainly considered the threat not the opportunities provided by Chinese. Larry D. Qiu (2005) studied how the Chinese textile industry had grown to present stage ,what the major reforms that has occurred .Paper also point out the major advantage & drawbacks in industry & also put forward some strategies which help to improve. . Gail Taylor (2004) studied special issue on the textile trade in China and its progress in recent years. It also outlined the relation of China textile with other members of WTO & its role as a major supplier .It also highlight problem related to tariff & various barriers.K F Au et al (2002) discussed about Textile & clothing industry in great China region n (China, Hong kong , Macau & Taiwan) based on advantage of integration of these four region & also said that their a much more to improve content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here.

3. TOPSIS METHOD

TOPSIS method was introduced for the first time by Yoon and Hwang and was appraised by surveyors and different operators. TOPSIS is a decision making technique. It is a goal based approach for finding the alternative that is closest to the ideal solution. In this method, options are graded based on ideal solution similarity. If an option is more similar to an ideal solution, it has a higher grade. Ideal solution is a solution that is the best from any aspect that does not exist practically and we try to approximate it. Basically, for measuring similarity of a design (or option) to ideal level and non-ideal, we consider distance of that design from ideal and non-ideal solution.

General TOPSIS process with 7 steps is listed below:-

Step 1

Form a decision matrix. The structure of the matrix can be expressed as follows

$$D = \begin{array}{c} \quad X1\ X2\ \ldots\ldots Xn \\ \begin{matrix} A_1 \\ A_2 \\ Ai \end{matrix} \begin{pmatrix} x_{11}\ x_{12} \ldots x_{1j} \ldots x_{1n} \\ x_{21}\ x_{22} \ldots x_{2j} \ldots x_{2n} \\ x_{i1}\ x_{i2} \ldots x_{ij} \ldots x_{in} \end{pmatrix} \end{array}$$

where

Ai = i^{th} alternative projects

Xij = the numerical outcome of the i^{th} alternative projects with respect to j^{th} criteria

Step 2

Normalize the decision matrix D by using the following formula:

$r_{ij} = x_{ij}/\sqrt{\Sigma}\ x_{ij}^2\{i=(1\ldots n)\}$

Step 3

Construct the weighted normalized decision matrix by multiplying the normalized decision matrix by its associated weights. The weighted normalized value vij is calculated as:

$v_{ij} = w_{ij} r_{ij}$

Step 4

Determine the positive ideal solution and negative ideal solution.

$A^* = \{(\max v_{ij} \mid j \epsilon J), (\min v_{ij} \mid j \epsilon J')\}$

$A^- = \{(\min v_{ij} \mid j \epsilon J), (\max v_{ij} \mid j \epsilon J')\}$

J = 1,2,3,....,n

where J is associated with the benefit criteria

J' = 1,2,3,....,n

where J' is associated with the cost criteria

Step 5

Calculate the separation measure.

The separation of each alternative from the positive ideal one is given by:

$Si^* = \sqrt{\Sigma}\ (v_{ij}-v_j^*)^2\{j=(1\ldots.n)\}$

where i = 1,2,...,m

Similarly, the separation of each alternative from the negative ideal one is given by:

$S_i^- = \sqrt{\Sigma}\ (v_{ij}-v_j^-)^2\{\ j=(1\ldots..n)\}$

Where i = 1,2,...,m

Step 6

Calculate the relative closeness to the ideal solution.

The relative closeness of Ai with respect to A* is defined as:

$Ci^* = Si^-/(Si^*+Si^-),\ 0 \le Ci^* \le 1$

where i = 1,2,...,m

The larger the Ci* value, the better the performance of the alternatives.

Step 7

Rank the preference order.

4. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process is a procedure designed to quantify managerial judgments of the relative importance of each of several conflicting criteria used in the decision making process. In this paper, we have used the following steps of AHP to help us to measure the relative importance or the weighted values of several criteria.

Step 1

List the overall goal, criteria and decision alternatives.

Step 2

Develop a pair wise comparison matrix.

Step 3

Develop a normalized matrix.

Step 4

Develop the priority vector.

Step 5

Rank the preferred criteria

5. PROPOSED METHODOLOGY

The proposed methodology for supplier selection problem, composed of TOPSIS method, consists of three steps. These are:

1. Identify the criteria to be used in the model.
2. Weight the criteria by using AHP.
3. Evaluation of alternatives with TOPSIS and determination of the final rank.

In the first step, we try to recognize variables and effective criteria in supplier

selection and the criteria which will be used in their evaluation is extracted. Thereafter, list of qualified suppliers are determined. In the second step, we assign weights to each criterion by using AHP. Finally, ranks are determined using TOPSIS method in the third step.

6.NUMERICAL EXAMPLE, CALCULATION AND RESULTS

In this section, to implement the methodology, we have solved simulated numerical example. Assume that the management of a manufacture in textile wants to choose their best suppliers among India & China. Based on proposed methodology, 3 steps are applied for assessment and selection of suppliers. In this part, we deal with application of these steps. We are going to evaluate India

Table-1: various suppliers & their respective attribute & China as alternatives against Quality of Rayon's, Strict Laws(including environmental aspect)(X_1), Digitalization of the Enterprises , flexibility & Rate of technological up gradation(X_2), Export Quantity ,Organization of Labor , Global market share(X_3) , Transportation ,Traffic, Labor facilities(X_4) , Product variety & Customization(X_5) , Delivery time for small batch size(X_6).

Supplier	Focus on quality (X_1)	Labor & pollution rules& laws (X_2)	Product Variety (X_3)	Transportation facilities (X_4)	Raw material cost (X_5)	Labor Cost (X_6)	Counterpart flexibility (X_7)	Institution & Research back	Export Cost (X_9)	Degree of Specialization (X_{10})	International Relation (X_{11})	Flexibility in production	Number of production	Dependency on import
India	Extremely high	Very Good	Very High	Good	Very High	Very High	Extremely High	High	Extremely High	High	Very High	Very High	Very High	Extremely High
China	Very High	Good	High	Very Good	High	High	High	Extremely High	High	Very high	High	High	High	High

Ten point scale chosen for above attributes are:

X_1 & X_4	X_2, X_5 & X_3	X_6
Good -5	High -5	Fast -5
Very Good -7	Very High -7	Very Fast -7
Extremely Good -9	Extremely High -9	
Extremely Fast -9		

Table-2 : Comparison of attributes

Compared to the 2nd alternative, the 1st alternative is:	Numerical Rating
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Equally preferred	1

Assumption

For supplier selection problem let us assume

1.We are going to evaluate India & China as alternatives against Focus on quality(X_1) , Labor & pollution rules& laws (X_2) , Product variety (X_3) , Transportation facility (X_4) , Raw material cost (X_5) ,Labor cost (X_6) , Counterpart flexibility(X_7) , Institutional & research back ground (X_8) , Export cost(X_9) , Degree of specialization (X_{10}) , International relation (X_{11}) ,Flexibility in production (X_{12}) , number of production centers (X_{13}) , Dependency on import Rayon (X_{14}).

2.Focus on quality(X_1) is extremely preferred over Raw material cost (X_5) , Dependency on import Rayon (X_{14}) ; strongly preferred over Transportation facility (X_4) , Labor cost (X_6) , Degree of specialization (X_{10}) , Export cost(X_9) , moderately preferred over Counterpart flexibility(X_7) , Flexibility in production (X_{12}) , Labor & pollution rules& laws (X_2) , Institutional & research back ground (X_8) , International relation (X_{11}) & equally preferred over Product variety (X_3).

3.Product variety (X_3) is extremely preferred over number of production centers (X_{13}) , Dependency on import Rayon (X_{14}) , very strongly preferred over Transportation facility (X_4) , strongly preferred over Labor & pollution rules& laws (X_2) , Raw material cost (X_5) , Labor cost (X_6) , Institutional & research back ground (X_8) , Export cost(X_9) ,Degree of specialization (X_{10}) , International relation (X_{11}) , equally preferred over Focus on quality(X_1), Flexibility in production (X_{12})

4.Raw material cost (X_5) is strongly preferred over Labor & pollution rules& laws (X_2) , Transportation facility (X_4) , Institutional & research back ground (X_8) , Degree of specialization (X_{10}) , International relation (X_{11}) , number of production centers (X_{13}) , moderately preferred over Labor cost (X_6) , Export cost(X_9) , Flexibility in production (X_{12}) equally preferred over Dependency on import Rayon (X_{14}).

5.Labor cost (X_6) very strongly preferred over Institutional & research back ground (X_8) , strongly preferred over Transportation facility (X_4) , moderately preferred over Degree of specialization (X_{10}) , International relation (X_{11}) , number of production centers (X_{13}) , Dependency on import Rayon (X_{14}) equally preferred over Labor & pollution rules& laws (X_2) , Export cost(X_9) , F lexibility in production (X_{12}) .

6.Counterpart flexibility(X_7) is extremely preferred over Institutional & research back ground (X_8) , very strongly preferred over Counterpart flexibility(X_7) , number of production centers (X_{13}) , strongly preferred over Labor & pollution rules& laws (X_2) , Product variety (X_3) , Labor cost (X_6) , Dependency on import Rayon (X_{14}) moderately preferred over Raw material cost (X_5) , Export cost(X_9) , Degree of specialization (X_{10}) , International relation (X_{11}) , Flexibility in production (X_{12}) .

7.Export cost(X_9) strongly preferred over Institutional & research back ground moderately preferred over Labor & pollution rules& laws (X_2) , Degree of specialization (X_{10}) , International relation (X_{11}) , equally preferred over Transportation facility (X_4) , Labor cost (X_6) , International relation (X_{11}) , Flexibility in production (X_{12}) , number of production centers (X_{13}) , Dependency on import Rayon (X_{14})

8.Degree of specialization (X_{10}) strongly preferred over Labor & pollution rules& laws (X_2) , International relation (X_{11}) moderately preferred over Transportation facility (X_4) , Institutional & research back ground (X_8) , number of production centers (X_{13}) , Dependency on import Rayon (X_{14}).

9.Flexibility in production (X_{12}) strongly preferred over Labor & pollution rules& laws (X_2) , Institutional & research back ground (X_8) , Degree of specialization (X_{10}) , moderately preferred over Transportation facility (X_4) , International relation (X_{11}) , number of production centers (X_{13}) , Dependency on import Rayon (X_{14}) equally preferred over Raw material cost (X_5) , Labor cost (X_6) , Export cost(X_9) .

10.Number of production centers (X_{13}) moderately preferred over Labor & pollution rules& laws (X_2) , Institutional & research back ground (X_8) , equally preferred over Transportation facility (X_4) , Export cost(X_9) , International relation (X_{11}) , Dependency on import Rayon (X_{14})

11.Dependency on import Rayon (X_{14}) moderately preferred over Labor & pollution rules& laws (X_2) , Transportation facility (X_4) , equally preferred over Raw material cost (X_5) , Export cost(X_9) , International relation (X_{11}) , number of production centers (X_{13})

12.International relation (X_{11}) moderately preferred over Transportation facility (X_4) , Institutional & research back ground (X_8) equally preferred over number of production centers (X_{13}) , Dependency on import Rayon (X_{14}).Institutional & research back ground (X_8) moderately preferred over Dependency on import Rayon (X_{14}).

13.Transportation facility (X_4) strongly preferred over Labor & pollution rules& laws (X_2) , moderately preferred over Institutional & research back ground (X_8) , equally preferred over Export cost(X_9) , number of production centers (X_{13})

14. Labor & pollution rules& laws (X_2) strongly preferred over Institutional & research back ground (X_8) , moderately preferred over International relation (X_{11}) , equally preferred over International relation (X_{11}).

Table-3 : showing the structure of a decision matrix

Supplier	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
India	9	7	7	5	7	7	9	5	9	5	7	7	7	9
China	7	5	5	7	5	5	5	9	5	7	5	5	5	5

Table -4: gives the normalized values of the decision matrix

Supplier	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
India	0.15	0.03	0.12	0.02	0.08	0.05	0.14	0.01	0.04	0.03	0.03	0.06	0.02	0.03
China	0.12	0.02	0.08	0.02	0.06	0.04	0.08	0.02	0.02	0.04	0.02	0.04	0.02	0.01

Table-5:Performing different steps of AHP

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_1	1	3	1	5	9	5	3	3	5	5	3	3	7	9
X_2	1/3	1	1/5	1/5	1/5	1	1/5	5	1/3	1/5	3	1/5	1/3	1/3
X_3	1	5	1	7	5	5	1/5	5	3	3	3	1	9	9
X_4	1/5	5	1/7	1	1/5	1/5	1/7	3	1	1/3	1/3	1/3	1	1/3
X_5	1/9	5	1/5	5	1	3	1/3	5	3	5	5	3	5	1
X_6	1/5	1	1/5	5	1/3	1	1/5	7	1	3	3	1	3	3
X_7	1/3	5	5	7	3	5	1	9	3	3	3	3	7	5
X_8	1/3	1/5	1/5	1/3	1/5	1/7	1/9	1	1/5	1/3	1/3	1/5	1/3	3
X_9	1/5	3	1/3	1	1/3	1	1/3	5	1	3	3	1	1	1
X_{10}	1/5	5	1/3	3	1/5	1/3	1/3	3	1/3	1	5	1/5	3	3
X_{11}	1/3	1/3	1/3	3	1/5	1/3	1/3	3	1/3	1/5	1	1/3	1	1
X_{12}	1/3	5	1	3	1/3	1	1/3	5	1	5	3	1	3	3
X_{13}	1/7	3	1/9	1	1/5	1/3	1/7	3	1	1/3	1	1/3	1	1
X_{14}	1/9	3	1/9	3	1	1/3	1/5	1/3	1	1/3	1	1/3	1	1

Table 6-Normalized comparison matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_1	0.24	0.07	0.10	0.11	0.42	0.21	0.44	0.05	0.24	0.17	0.09	0.20	0.16	0.22
X_2	0.08	0.02	0.02	0.00	0.01	0.04	0.03	0.09	0.02	0.01	0.09	0.01	0.01	0.01
X_3	0.24	0.11	0.10	0.16	0.24	0.21	0.03	0.09	0.14	0.10	0.09	0.07	0.21	0.22
X_4	0.05	0.11	0.01	0.02	0.01	0.01	0.02	0.05	0.05	0.01	0.01	0.02	0.02	0.01
X_5	0.03	0.11	0.02	0.11	0.05	0.13	0.05	0.09	0.14	0.17	0.14	0.20	0.12	0.02
X_6	0.05	0.02	0.02	0.11	0.02	0.04	0.03	0.12	0.05	0.10	0.09	0.07	0.07	0.07
X_7	0.08	0.11	0.49	0.16	0.14	0.21	0.15	0.16	0.14	0.10	0.09	0.20	0.16	0.12
X_8	0.08	0.00	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.07
X_9	0.05	0.07	0.03	0.02	0.02	0.04	0.05	0.09	0.05	0.10	0.09	0.07	0.02	0.02
X_{10}	0.05	0.11	0.03	0.07	0.01	0.01	0.05	0.05	0.02	0.03	0.14	0.01	0.07	0.07
X_{11}	0.08	0.01	0.03	0.07	0.01	0.01	0.05	0.05	0.02	0.01	0.03	0.02	0.02	0.02
X_{12}	0.08	0.11	0.10	0.07	0.02	0.04	0.05	0.09	0.05	0.17	0.09	0.07	0.07	0.07
X_{13}	0.03	0.07	0.01	0.02	0.01	0.01	0.02	0.05	0.05	0.01	0.03	0.02	0.02	0.02
X_{14}	0.03	0.07	0.01	0.07	0.05	0.01	0.03	0.01	0.05	0.01	0.03	0.02	0.02	0.02

Table 7- weighted normalized decision matrix

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
India	0.15	0.03	0.12	0.02	0.08	0.05	0.14	0.01	0.04	0.03	0.03	0.06	0.02	0.03
China	0.12	0.02	0.08	0.02	0.06	0.04	0.08	0.02	0.02	0.04	0.02	0.04	0.02	0.01

Table 8- the positive ideal solution and the negative ideal solution

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
A*	0.153	0.025	0.116	0.024	0.057	0.036	0.145	0.016	0.025	0.031	0.027	0.062	0.016	0.015
A-	0.119	0.018	0.083	0.017	0.080	0.050	0.080	0.012	0.045	0.043	0.015	0.044	0.023	0.027

Table 9- separation measures, the relative closeness coefficient and the ranking of different Suppliers

Suppliers	Si*	Si-	Ci*
India	0.037	0.084	2.33
China	0.196	0.0372	0.16

7. CONCLUSION

In supplier selection considering all criteria's & all factors which has taken from various journal paper, government sites & issues we can conclude that India is a better option of supplier in textiles.

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