Constructing Trade Barrier Index for Selected countries of South Asia

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1. Introduction

Over the past few decades, the world trading system has become increasingly open and competitive. Tariffs have been reduced in both developed and developing countries and quantitative restrictions have been progressively eliminated. Countries have adopted outward-looking economic policies, seeking to promote growth and employment through expanding export production and attracting inward investment. World trade is increasing at a significantly faster rate than global economic growth, spurred on by the fragmentation of production. This has generated a massive growth in the movement of parts, components, semi-manufactured goods and sub-assemblies between production units in different countries before the final products are assembled and sold.

Intense competition compels firms to reduce costs throughout their manufacturing and distribution processes. Outsourcing to lower cost firms and countries has been one major source of cost reduction, reduced inventory costs through just-in-time manufacturing, and distribution systems has been another. Both are predicated on efficient, reliable and low-cost supply chains. With the worldwide fall in tariff levels, the efficiency of supply chains and the associated logistics costs are becoming core determinants of the competitiveness of both firms and countries. They may also influence the destination of inward direct investment; many countries can offer low labor costs and tax incentives, fewer can offer quick, efficient, reliable and low cost logistics.

Like the rest of the world, South Asia has also moved from import substitution to more liberal trade policies and export promotion, and its international trade has grown very rapidly. The region, however, continues to have a very small share of global trade (less than 2 percent) and exports still play a limited role in GDP. Trade is overwhelmingly with the rest of the world, intra-regional trade constitutes less than 5 percent of total trade, the lowest level of any region in the world.

South Asia is often perceived as having very poor external supply chains - inefficient ports, long delays, cumbersome customs procedures, etc. Published international surveys, such as the World Bank's "Doing Business", have tended to confirm the perceptions. South Asia performed poorly on all "trading across border" measures requiring more documents, time, and cost than either developed countries or East Asia. A regional integration agenda can never successful without proper trade facilitation practices. This is especially true for the SMEs who are often the major driving force for the intra-regional trade in South Asia. There identification of trade barriers is a crucial aspect of any trade integration agenda for this region. This has not received yet received the desired attention, but increasingly it is gaining prominence in policy circles.

In recent years, World Bank has been publishing Logistics' barrier index for all the countries of the South Asia on an annual basis. No doubt, this is a positive development highlighting the trade facilitation problems of the South Asian countries. However, these indices focus on each country's barrier with respect to rest of the world. The nature of impediments in trading among themselves is not at all highlighted in these indices. However if we go by literature on trade facilitation problems in respect of South Asian countries, impediments in trading among themselves is believed to be much than trading with countries outside the region. While this aspect has been raised by many researchers, there is dearth of quantitative studies in highlighting the extent of trade barriers in trading among themselves and in relative position among themselves. This paper is an attempt in this direction. To be specific, our aim is to construct the indices of Trade Barrier for major South Asian countries namely, India, Bangladesh, Sri Lanka, Pakistan and Nepal. It must be mentioned that the study (trade barrier indices) focuses solely on the trade relationship between India and each of these countries. Thus our focus is solely on barriers of trade between India and her South Asian neighboring countries (Bangladesh, Sri Lanka, Pakistan and Nepal).

2. The Data

It is obvious that secondary information is not sufficient to construct trade barrier index for South Asia. For this reason, undertook primary surveys in the South Asian countries to collate information

for constructing trade barrier index. The surveys are conducted in the following South Asian countries, namely India, Bangladesh, Sri Lanka, Pakistan and Nepal. The respondents to our surveys are exporter, importers, and freight-forwarder, who are engaged in trade between India and her South Asian partner countries. It is believed that they would be in a better position to provide information on impediments. We have used a structured questionnaire to solicit information on impediments (see Annex 1 for the questionnaire). As Annex 1 indicates, the respondents have been asked to give perception about the impediments in a scale of 0–5. The impediments have also been classified by modes of transports such as road, rail, sea, and air. Information has also been collated on various categories of impediments under each modes of transport. Additionally, respondents were also asked to report whether any changes have occurred in the last 5 years on a scale of 0-5. In all, we have collated about 70 respondents (filled in questionnaires) for impediments for trade between India and her South Asian partner countries. In other works, we have four sets of respondents of about 140 each, representing respondents engaged in trading between IndiaadNepal, India and Bangladesh, India and Sri Lanka and India and Pakistan. Each set of respondents are further divided into two equal groups. One group comprises of respondents within India while the second group includes respondents in the corresponding partner country. This way of collating information enables us to capture degree of impediments in a neutral way.

3. Methodology

To rank the countries in terms of barriers to trade, it is essential to reduce the relevant factors or variables into one single measure or a composite index for a specific country. Thus, composite index can be defined as a linear combination of variables assigning equal or different weights to the variables. These weights can be determined subjectively or with the help of statistical or econometric technique to make it objective in nature. In many cases, equal weights are used to form the composite index where it is assumed that each and every variable is equally important in explaining the phenomenon.1Sometimes, subjective weights are used when the importance of the

[1] In fact, this is the approach that has been followed by World Bank's logistics' index.

variables is known apriori and imposed externally. However, assigning equal weights to variables or assigning weights subjectively are generally characterized with biasness in the result.

According to our questionnaire of impediments, the parameters are grouped into broad parameters, sub-parameters and sub-sub-parameters. As Table 1 indicates, the broad parameters are categorized into following types of barriers:

1. General barriers,
2. Road transport related barriers,
3. Rail transport related barriers,
4. Sea transport related barriers and
5. Air transport related barriers.

Each of these broad parameters is further divided into several sub-parameters and some of them are further sub-divided into sub-sub-parameters. The list of broad parameter and sub-parameters along with the number of sub-sub-parameters are given in Table 1. The details of these are given in Annex 2.

Table 1 List of Broad Parameters, Sub-Parameters and Number of Sub-Sub Parameters

Broad Parameters	Sub-Parameters	Number of Sub-Sub parameters
GENERAL	Efficiency in processing of Pre-shipment/ pre-arrival documents	-
	Meeting Standards	-
	Business Mobility	2
	Competence of the logistics industry	2
	Trade Policy	4
	Availability and efficiency of banks for processing documents	-
	Availability and effectiveness of insurance facilities	-
ROAD TRANSPORT	Physical Transport	-
	Bilateral Transport Protocols	-
	Customs and Documentation	10
	Infrastructure at LCS	7
	Transaction costs	5
	Delivery times	2

Table 1 List of Broad Parameters, Sub-Parameters and Number of Sub-Sub Parameters

Broad Parameters	Sub-Parameters	Number of Sub-Sub parameters
RAIL TRANSPORT	Physical Transport	-
	Bilateral Transport Protocols	-
	Customs and Documentation	10
	Infrastructure at LCS	7
	Transaction costs	5
	Delivery times	2
SEA TRANSPORT	Physical Transport	-
	Bilateral Transport Protocols	-
	Customs and Documentation	10
	Infrastructure at LCS	7
	Transaction costs	5
	Delivery times	2
AIR TRANSPORT	Physical Transport	-
	Bilateral Transport Protocols	-
	Customs and Documentation	10
	Infrastructure at LCS	7
	Transaction costs	5
	Delivery times	2

We have used a few steps before computing the final Index of the trade barriers for the countries/perspectives under the study. Through the questionnaire, the perceptions of the exporters/importers of the relevant perspectives have been captured at the level of the sub-sub-parameters. Initially we use the average values of each of these sub-sub-parameters to arrive at an index for the sub-parameters. At the next step, we used the index values for sub-parameters for obtaining values at the broad parameters. At the final stage, we construct the composite index of trade barriers for each of the perspectives as mentioned above using the values of the broad parameters.

We have used Principal Component Analysis, which is a part of the Factor Analytic Technique, to construct the trade barrier index of the countries. This method has been extensively used by regional scientists because of its optimality property. The procedure of the principal component analysis has been given in its simplest form in Annex 3.

The first principal component, which has adequate explanatory capacity within the model, has been used to form the composite index. This is characterized by the property of having the largest sum of squared correlations amongst variables and hence is the best suited one use for the given purpose. Since the weights are determined solely by the relationships amongst the variables, the procedure completely removes the biasness on part of the researcher during the analysis stage. For observations where the numbers were missing for certain variable, we have replaced the same with the mean value so that the variable is not dropped from the analysis.

4. Results

In this section, we present the results of the composite index of trade barriers and the broad parameters considered for computing the composite index, which is a linear combination of these components. It is important to remember that the composite index computed through Principal Component Analysis is essentially a relative measure. An individual score only shows its relative strength compared to others and does not depict its magnitude in an absolute sense. The index has been computed with the help of standardized data and hence has a mean value of zero and standard deviation as 1. Since this is a comparative measure across countries, we have classified them in three groups. These groups are countries with relatively higher trade barrier, average trade barrier and lower trade barrier rather than considering them as single data points. These groups are formed based on mean and standard deviation of the data.

Table 2 presents the pair-wise correlation coefficients of the indicators used to arrive at the final composite index of trade barriers. It is important to remember here that these correlation coefficients are not the result of any causal relationship, the variables are assumed to be independent of each other. The pattern of the correlation matrix suggests that all the variables included in the model reveal moderate to high correlation with other variables except for a few cases.

Table 2 Correlation Coefficients between Broad Parameters

Broad parameters	General	Road Transport	Rail Transport	Sea Transport	Air Transport

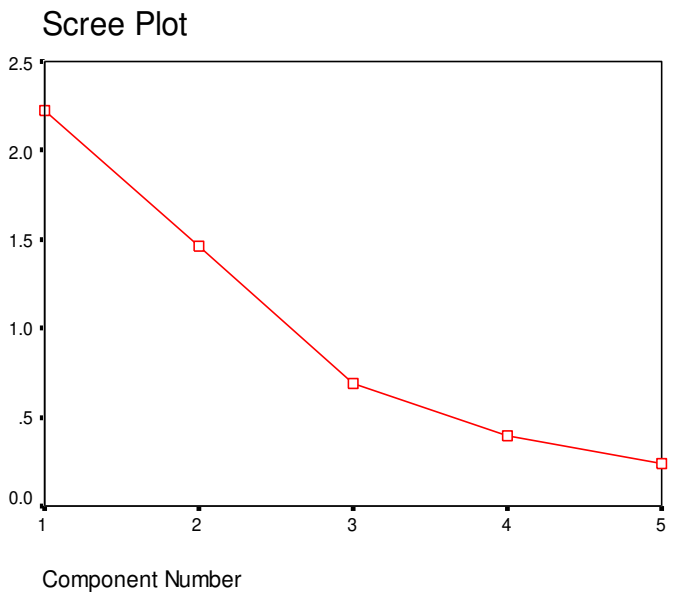
General	1.00	0.47	0.53	0.26	0.24
Road Transport	0.47	1.00	0.33	0.46	-0.38
Rail Transport	0.53	0.33	1.00	0.38	0.37
Sea Transport	0.26	0.46	0.38	1.00	-0.09
Air Transport	0.24	-0.38	0.37	-0.09	1.00

We have confirmed the statistical validity of inclusion of all these variables in our model through statistical tests. There are number of ways of assessing whether a set of variables in the correlation matrix is suitable for factor analysis. Out of these, we have used Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) for our analysis. The value of this statistics ranges from 0 to 1. In our model, the KMO statistic is found to be 0.67 which suggests that the correlation coefficients, on the whole, are sufficiently high to make the analysis suitable.

We have already mentioned that the first principal component of the model has been considered to form the composite index of trade barriers. The model derived 5 principal components as there are 5 variables included in it. The strength of each factor in representing the model is computed by the corresponding eigen values. The eigen value is also suggestive of the explanatory capacity of a particular component. The percentage of variance being explained by the first principal component is about than 45%. These facts along with the scree plot are indicative of the fact that the first principal component is suitable enough to be used for computing the composite index of trade barrier[2].

[2]A scree plot shows the contribution of the components in the model. It suggests that the components have less contribution to the model from the point the curve becomes smooth.

Figure 1: Scree Plot



In the methodology section of this chapter, we discuss the importance of the weight assigned to each variable. The final form of composite index depends a lot on the weight scheme derived by the model. Table 3 shows the relative weights of the variables used in our analysis.

Table 3 The weights of the Indicators for the Final Composite Index

Indicator	Weight	Relative weight (%)
General	0.783	25.34
Road Transport	0.729	23.59
Rail Transport	0.784	25.37
Sea Transport	0.674	21.81
Air Transport	0.120	3.90

These weights have been used to combine the variables linearly to arrive at the composite index. The composite scores have been classified into 3 groups on the basis of the mean and standard deviation across the countries/perspectives. The composite scores for each of the perspectives are given in Table 4. One should remember while interpreting the scores that these are relative in nature and should be interpreted as 'higher the value higher the level of trade barrier of the country. Given the nature of the composite index, it is better to study them in groups rather than compare them in terms of the magnitude of the composite index. It seems from the data in Table 4 that Indian traders

face least impediments in trading with Sri Lanka. By contrast, maximum impediments is faced by Nepalese traders.

Table 4 The Final Composite Index

Country/Perspective	Composite Index of Trade Barriers	Rank Based on Composite Index	Level of Trade Barrier
India perspective of Bangladesh	-0.39	5	Average
India perspective of Pakistan	-0.75	7	Lower
India perspective of Nepal	0.28	3	Average
India perspective of Sri Lanka	-0.76	8	Lower
Bangladesh perspective of India	-0.44	6	Average
Sri Lankan perspective of India	0.46	2	Average
Nepal's perspective of India	1.41	1	Higher
Pakistan's perspective of India	-0.21	4	Average

The above composite index, the trade barriers related all the transport modes were included in the analysis. These include road transport between India- Sri Lanka and sea transport between India-Nepal which does not take place. Proxies had been used for the above two instances to allow comparison across all the five countries, which was unavoidable due to model specification. To have a clear understanding of the fact that whether these proxies could alter the results in terms of trade barrier index, we have constructed trade barrier index only with the help of barriers related to general and road transport parameters. Sri Lanka had been dropped since it does not have any road link with India. However, the new composite index including these 2 broad parameters also show similar trend which is presented in Table 5. This is a weighted composite index of first 5 components since the explanatory capacity of the individual components were not large enough to be considered as representative one exclusively for the constructing the composite index.

Table 5: Weighted Composite Index for General and Road Transport Parameters

Country/Perspective	Composite Index of Trade Barriers	Rank Based on Composite Index	Level of Trade Barrier
Nepal's perspective of India	0.810	1	Higher
Pakistan's perspective of India	0.144	2	Average
Bangladesh perspective of India	0.064	3	Average
India perspective of Bangladesh	-0.076	4	Average
India perspective of Pakistan	-0.318	5	Average
India perspective of Nepal	-0.624	6	Lower

5. Validation of Results

In the earlier section, we have ranked the countries according to the impediments based on our econometric exercise. Naturally, one looks for the validation of the results. In this section, we have basically attempted the same.

Table 6 represents the correlation between Trade Barrier Index and the broad indicators used for construction of the index. It shows relatively higher correlations with road transport and sea transport.

Table 6 Relationship between Trade Barrier Index and the broad indicators

Broad Parameters	Correlation coefficients Trade Barrier Index
General	0.178
Road Transport	0.491
Rail Transport	0.106
Sea Transport	0.358
Air Transport	-0.362

The literature on trade barriers reports that not only it affects the trade flow across countries, but it also increases the transaction costs significantly. Out of these, transaction costs in the form of bribe (speed money) and damages are generally the two most important ones. Information was solicited on these two components while conducting the primary survey in the countries under study. Since the amount of bribery or the damages depend on several externalities such as product being traded and its nature, consignment value and similar ones, to maintain parity across traders in intra- and inter-country analysis, the questionnaire sought information on the percentage of speed money of the total consignment value. Similarly, damage related transaction costs have also been captured in the similar manner. We have computed the average for each of the country/perspective studies here. The following table has given a snapshot of the average percentage of bribe and damage along with the index of the trade barrier for the respective perspectives.

Table 7 Relationship of Trade Barrier Index with Bribe and Damages

Country/Perspective	Composite Index of Trade Barriers	Average % Bribe	Average % Damage

India perspective of Bangladesh	-0.39	3.50	3.05
India perspective of Pakistan	-0.75	3.13	3.79
India perspective of Nepal	0.28	3.33	3.74
India perspective of Sri Lanka	-0.76	2.84	3.23
Bangladesh perspective of India	-0.44	2.60	0.13
Sri Lankan perspective of India	0.46	6.13	3.78
Nepal's perspective of India	1.41	4.45	11.60
Pakistan's perspective of India	-0.21	0.92	1.81

The relationship between the trade barrier index with incidence of bribery and damages faced by the exporters/importers has been shown visually through scatter diagrams given below separately for bribery and damages. Both the scatters clearly depict a strong positive relationship between trade barrier indexes with the transaction costs of concern here. To substantiate the findings from visual representation, we computed the correlation coefficients between these two transaction costs with the trade barrier index. The correlation coefficient between trade barrier index and percentage of bribery is 0.59 and the coefficient between trade barrier index and damage is 0.79. Both visual representation and correlation coefficients strongly suggest that trade barriers have significant contribution towards bribery and damages. Higher the trade barrier higher is the average percentage bribery and the same is true for damages also. The similar relation was also evident in case of trade barrier index for road transport with bribery and damages with correlation coefficients of 0.19 and 0.61 respectively. This strongly suggests that poor road transport facilities affect the trade significantly though substantially high damages. Therefore, any step towards reducing trade barriers will result in significant reduction in bribery as well as damages.

Figure 2: Relation between Trade Barrier and Bribe

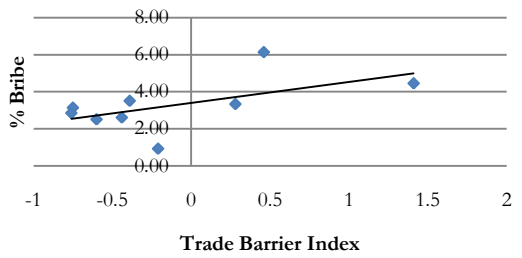
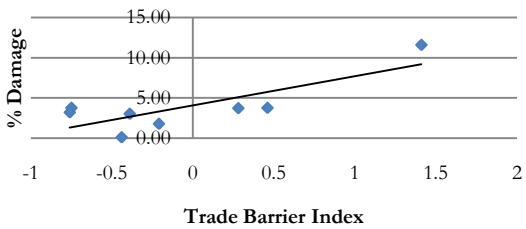
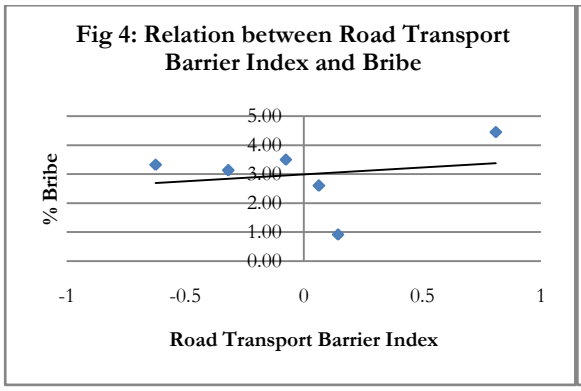
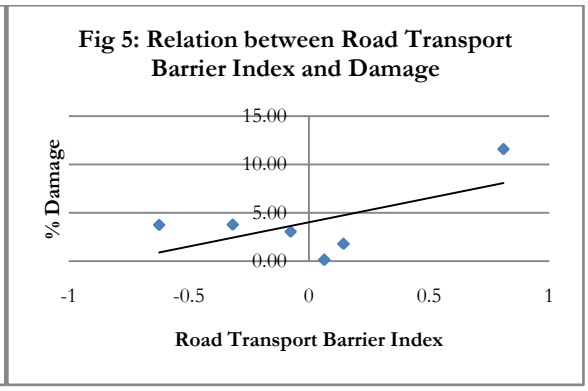


Fig 3: Relation between Trade Barrier and Damage







6. Relationship of Index Values and Changes in Trade Barriers

The reduction in impediments between themselves would no doubt boost intra–SAARC trade. It is generally believed that impediments have declined in recent years. To understand changes in the trade barrier related issues, information was also solicited from the respondents about the degree of change in a scale of 0-5. We have computed the average change reported for each of the broad parameters for every perspective selected for this study based on their responses. The relationships between trade barrier index and changes reported on the trade barriers during last 5 years for the broad parameters are presented Table 8 and Table 9. Correlation coefficients depict that there is a negative relationship between changes in trade barrier reported and trade barrier index values except for air transport and sea transport. This indicates that higher the change in trade barriers lower is the trade barrier index values. However, we need to consider this phenomenon as more of an indicative one rather than a robust statistical result. The reason behind the same is non-applicability of some of the facilities for specific countries reduce the data points for analysis purpose at the parameter level. For an example, the rail and road transport facilities are not applicable for the trade between India and Sri Lanka.

Table 8: Correlation between Broad Parameter Index and Changes in those parameters in last 5 years

Parameter	Correlation with Changes in last 5 Years
General	-0.84
Road transport	0.16
Rail transport	-0.46
Sea transport	0.02
Air transport	0.58

Table 9: Correlation between Overall Trade Barrier Index and Changes in Broad Parameters in last 5 years

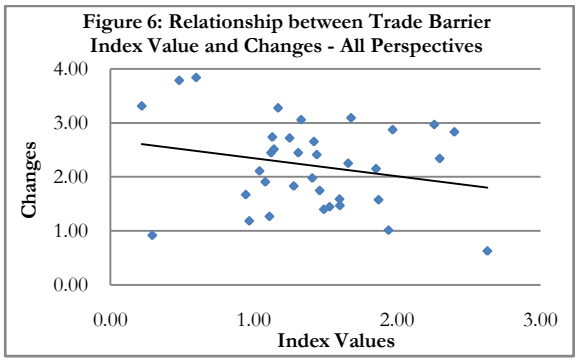
Changes in Parameters in Last 5 Years	Correlation with Overall Index
General	-0.57
Road transport	0.07
Rail transport	-0.36
Sea transport	-0.70
Air transport	-0.72

To overcome this problem and to substantiate this finding, we have also done the same analysis at the country/perspective level. The correlations between changes in trade barriers during the last 5 years as reported by the traders for all broad parameters and the barrier index related to those parameters of a specific country/perspective have been presented in Table 10. For each of the country except Nepal, a clear negative relation has been observed. Figure 14 presents the same relationship for all the countries put together. The scatter obtained from Figure 6 as well as the correlation coefficient of -0.23 obtained from the data for all countries together, suggest that the changes envisaged by the trading community has reduced the trade barriers in general. However, as

mentioned earlier, this result should be treated as an indicative trend and not as a statistically valid trend since the number of observations for each country was limited.

Table 9: Correlation between Parameter-wise Trade Barrier Indices and Changes in Those Parameters in last 5 years

Country specific perspective	Correlation
India perspective of Bangladesh	-0.73
India (North East) perspective of Bangladesh	-
India perspective of Pakistan	-0.31
India perspective of Nepal	-0.33
India perspective of Srilanka	-0.85
Bangladesh	-0.29
Pakistan	-0.68
Sri Lanka	-0.61
Nepal	0.95



Annex 1

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Annex 2
Detailed List of Parameters

Broad Parameter	Sub-Parameters	Sub-Sub parameters
GENERAL	Efficiency in processing of Pre-shipment/ pre-arrival documents	
	Meeting Standards	
	Business Mobility	a) Obtaining visas
		b) Business travel
	Competence of the logistics industry (Transport operators, Customs brokers, Freight Forwarders, Clearing Agents)	a) Small operators
		b) Large operators
	Trade Policy	a) MFN
		b) Port Restrictions
		c) Implementation of Quotas
		d) Rules of Origin
	Availability and efficiency of banks for processing documents (e.g. L/C, insurance, foreign exchange etc)	
	Availability and effectiveness of insurance facilities	
ROAD TRANSPORT	Physical Transport	
	Bilateral Transport Protocols	
	Customs and Documentation	a) Number of documents required to clear goods
		b) Processing of documents by customs
		c) Testing
		d) Efficiency in processing of documents by health/technical control agencies
		e) Competence of customs officials
		f) Customs awareness of Trade Policy
		g) Transparency of Border Administration
		h) Classification of products
		i) Excessive checks due to security measures
		j) Effectiveness of EDI facilities
	Infrastructure at LCS	a) Access to the LCS
		b) Availability of Services at the LCS
		c) Quality of Services at the LCS
		d) Congestion at border/ LCS
		e) Availability and use of Information Technology (computers, internet etc)
		f) Availability of power
		g) Physical Security
	Transaction costs	a) Transport Costs
		b) Port/LCS Charges
		c) Handling charges
		d) Inspection charges

Annex 2
Detailed List of Parameters

Broad Parameter	Sub-Parameters	Sub-Sub parameters
		e) Bribes (Unofficial costs)
	Delivery times	a) Delays from scheduled delivery times
		b) Damages due to delays in delivery
RAIL TRANSPORT	Physical Transport	
	Bilateral Transport Protocols	
	Customs and Documentation	a) Number of documents required to clear goods
		b) Processing of documents by customs
		c) Testing
		d) Efficiency in processing of documents by health/technical control agencies
		e) Competence of customs officials
		f) Customs awareness of Trade Policy
		g) Transparency of Border Administration
		h) Classification of products
		i) Excessive checks due to security measures
		j) Effectiveness of EDI facilities
	Infrastructure at LCS	a) Access to the LCS
		b) Availability of Services at the LCS
		c) Quality of Services at the LCS
		d) Congestion at border/ LCS
		e) Availability and use of Information Technology (computers, internet etc)
		f) Availability of power
		g) Physical Security
	Transaction costs	a) Transport Costs
		b) Port/LCS Charges
		c) Handling charges
		d) Inspection charges
		e) Bribes (Unofficial costs)
	Delivery times	a) Delays from scheduled delivery times
		b) Damages due to delays in delivery
	Physical Transport	
	Bilateral Transport Protocols	
		a) Number of documents required to clear goods
		b) Processing of documents by customs
		c) Testing

Annex 2
Detailed List of Parameters

Broad Parameter	Sub-Parameters	Sub-Sub parameters
SEA TRANSPORT	Customs and Documentation	d) Efficiency in processing of documents by health/technical control agencies
		e) Competence of customs officials
		f) Customs awareness of Trade Policy
		g) Transparency of Border Administration
		h) Classification of products
		i) Excessive checks due to security measures
		j) Effectiveness of EDI facilities
	Infrastructure at LCS	a) Access to the LCS
		b) Availability of Services at the LCS
		c) Quality of Services at the LCS
		d) Congestion at border/ LCS
		e) Availability and use of Information Technology (computers, internet etc)
		f) Availability of power
		g) Physical Security
	Transaction costs	a) Transport Costs
		b) Port/LCS Charges
		c) Handling charges
		d) Inspection charges
		e) Bribes (Unofficial costs)
	Delivery times	a) Delays from scheduled delivery times
		b) Damages due to delays in delivery
	Physical Transport	
	Bilateral Transport Protocols	
	Customs and Documentation	a) Number of documents required to clear goods
		b) Processing of documents by customs
		c) Testing
		d) Efficiency in processing of documents by health/technical control agencies
		e) Competence of customs officials
		f) Customs awareness of Trade Policy
		g) Transparency of Border Administration
		h) Classification of products
		i) Excessive checks due to security measures

Annex 2
Detailed List of Parameters

Broad Parameter	Sub-Parameters	Sub-Sub parameters
AIR TRANSPORT		j) Effectiveness of EDI facilities
	Infrastructure at LCS	a) Access to the LCS
		b) Availability of Services at the LCS
		c) Quality of Services at the LCS
		d) Congestion at border/ LCS
		e) Availability and use of Information Technology (computers, internet etc)
		f) Availability of power
		g) Physical Security
	Transaction costs	a) Transport Costs
		b) Port/LCS Charges
		c) Handling charges
		d) Inspection charges
		e) Bribes (Unofficial costs)
	Delivery times	a) Delays from scheduled delivery times
		b) Damages due to delays in delivery

Annex - 3

Methodology-Principal Components Analysis

This approach develops a composite index by defining a real valued function over the relevant variables would permit defining the potentials of the districts objectively. A set of assumptions behind our method of construction of a composite index is given below:

1. the condition of weak Pareto rule demands that when a district registers values of indicators uniformly higher than those of the other districts - the former should have a higher ranking than the latter ones;
2. the condition of non-dictatorship implies that no single indicator should be considered so significant as to determine the final ordering all by itself;
3. the condition of unrestricted domain implies that the method should be capable of giving the final ranking for all possible data matrices;
4. the final condition is that of independence from irrelevant alternatives, which demands that while ranking two districts, the decision must be guided by the values of the indicators for these units under study alone and not by any other irrelevant phenomenon;

With these general assumptions, the composite index is defined as,

$C_i = W_1x_{11} + W_2x_{12} + W_3x_{13} + \ldots\ldots\ldots\ldots + W_nx_{1n}$

or, $C_i = \sum W_i x_{ij}$, where C_i is the composite index for the ith observation, W_j is the weight assigned to j^{th} indicator and x_{ij} is the observation value after elimination of the scale bias.

From the above stated formula of the composite index it is evident that to compute the composite index two major components are to be known, i.e., the weights assigned to the indicators and the observation values after eliminating of the scale bias for the available indicators. These two have been discussed below in detail.

Elimination of scale bias

Variables chosen for any analysis are usually measured in different units and are generally not additive. Hence it is necessary to convert them in some standard comparable units such that the initial scale chosen for measuring them do not bias the results. The method which was adopted to achieve this is by standardizing the variables in the following way-

$$x_{ij} = (X_{ij} - X_m / \sigma)$$

where x_{ij} is the scale free observation, X_{ij} is the original observation and X_m is the mean of the series and σ is the standard deviation.

The transformed series now would be scale free and would have a mean of zero and a standard deviation of unity.

Assigning weights objectively using Factor Analytic Model

Once the bias of measurement is removed from the observations, the crucial problem that remains is that of assigning appropriate weights to the selected indicators. If one has sufficient insight into the nature and magnitude of interrelationships among the variables and their implications, one might choose to determine the weights on the basis of independent judgment. This way of constructing an index stands exposed to subjectivity. Assigning equal weight (or no weight) would imply assumption of equal correlation of each indicator with the composite index of importance which would hardly be a realistic approach in this case. Therefore, in this analysis the weights for individual indicators have been assigned on the basis of the factor analytic model.

Factor analysis is a tool used to construct a composite index in such a way that the weights given maximize the sum of the squares of correlation (of the indicators with the composite index). The application of Factor Analysis or Principal Component Analysis in this specific case has been accepted in 'objective ranking' of the regions. This method enables one to determine a vector known as the first Principal Component or Factor, which is linearly dependent on the variables, having the maximum sum of squared correlation with the variables.

The weights to the indicators are chosen in such a way so that the Principal Components satisfy two conditions:

a) The number of Principal Components is equal to the number of indicators and they are uncorrelated or orthogonal in nature.

b. The first Principal Component or P_1 absorbs or accounts for the maximum possible proportion of variation in the set of the indicators. This is the reason why it serves as the ideal measure of composite index.

Method Outlined

Step 1 We start by taking the simple correlation coefficients of the k numbers of indicators. These correlation coefficients may be arranged in a table which is called the correlation table. The elements of the diagonal would be unity as they are the self correlation, i.e., the correlation of each X_i with itself ($r_{xixi} = 1$ for all the i's). The correlation matrix is symmetrical, i.e., the elements of each row are identical to the elements of the corresponding columns, since $r_{xixj} = r_{xj\ xi}$.

Correlation Table of the set of K Variables					
	X_1	X_2	X_3	X_k	$\Sigma^k_i r_{xixj}$
X_1	$r_{x1\ x1}$	$r_{x1\ x2}$	..	$r_{x1\ xk}$	$\Sigma^k_i\ r_{x1xi}$
X_2	$r_{x2\ x1}$	$r_{x2\ x2}$	..	$r_{x2\ xk}$	
"	..	..	..	..	
"	..	..	..	..	
X_k	..	..	..	..	
"	$r_{xk\ x1}$	..	..	r_{xkxk}	
$\Sigma^k_i\ r_{x1xj}$	$\Sigma^k_i r_{xix1}$	$\Sigma^k_i r_{xix2}$	$\Sigma^k_i r_{xix3}$	$\Sigma^k_i r_{xixk}$	$\Sigma^k_i \Sigma^k_i r_{xixj}$

Step 2 Sum of each column (or row) of the correlation table is computed, obtaining k number of sums of simple correlation coefficient.

$$\Sigma^k_i r_{xixj} = \Sigma^k_i r_{xixj}$$

Step 3 We compute the sum total of the column (or row) sums-

$$\Sigma^k_i \Sigma^k_j r_{xixj}$$

and we take its square roots.

Step 4 Finally, we obtain the factor loadings for the first Principal Component P_1 by dividing each column (or row) sum by the square root of the grand total.

$$a_{ij} = (\Sigma^k_i r_{xixj}) / (\sqrt{\Sigma^k_i \Sigma^k_i r_{xixj}})$$

It should be clear that the loadings thus obtained are the correlation coefficients of the respective indicator with the composite index.

Step 5 The P_1 or the first Principal Component is constructed in the following way

$$P_1 = a_{11} x_1 + a_{12} x_2 + \ldots\ldots\ldots\ldots + a_{1k} x_k$$

Step 6 The sum of the squares of the loading of the Principal Component is called the latent root (or eigen value) of this component and are denoted by the Greek letter l with the subscript of the Principal Component to which it refers. For example, the latent root of the first Principal Component P_1 is

$$l_1 = [\text{latent root of } P_1]$$
$$= \Sigma^k_i \, 1^2_I$$
$$= 1^2_1 + 1^2_2 + \ldots + 1^2_k$$

The sum of the latent root of all the Principal Components would be equal to the number of indicators -

$$\Sigma^k_i \, l_i = k$$

The importance of the latent root or the eigen value lies in the fact that it expresses the percentage of variation in the set of indicator the Principal Component explains. If for example, $l_1 = 2.797$ and the number of variables are 8, then the P_1 expresses -

$$l_1 / k = (2.797/8)*100 = 35\ \%$$ of the variations of the set of 8 variables.

Tests of significance of the loadings: The loadings in our study have been tested based on the levels of significance of the Pearson Correlation coefficients.