



A STUDY ON THE PERFORMANCE EFFICIENCY OF CEMENT SECTOR IN INDIA

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ABSTRACT

Data Envelopment Analysis (DEA) is used for measuring the relative performance of organizational units where the attendance of multiple inputs and outputs makes comparisons difficult, is non-parametric linear programming based technique. The aim of this paper is to measure the performance of selected cement companies. We collect data of some chosen Cement Industry for years 2011 to 2015, the required data for the year 2016 is not available. Here, we use DEA methodology for a study on the performance efficiency of Cement Industries in India. DEA in operations research and economics for the estimation of production limits. The research is measured productive efficiency of decision making units with best-practice relationship between multiple outputs and multiple inputs to be estimated. The study found the efficient and inefficient companies during the year 2011 to 2015, on the basis of scale efficiency, overall technical efficiency and pure technical efficiency. Here study also shows the how to companies reduce their loss and earn maximum profit in the operation.

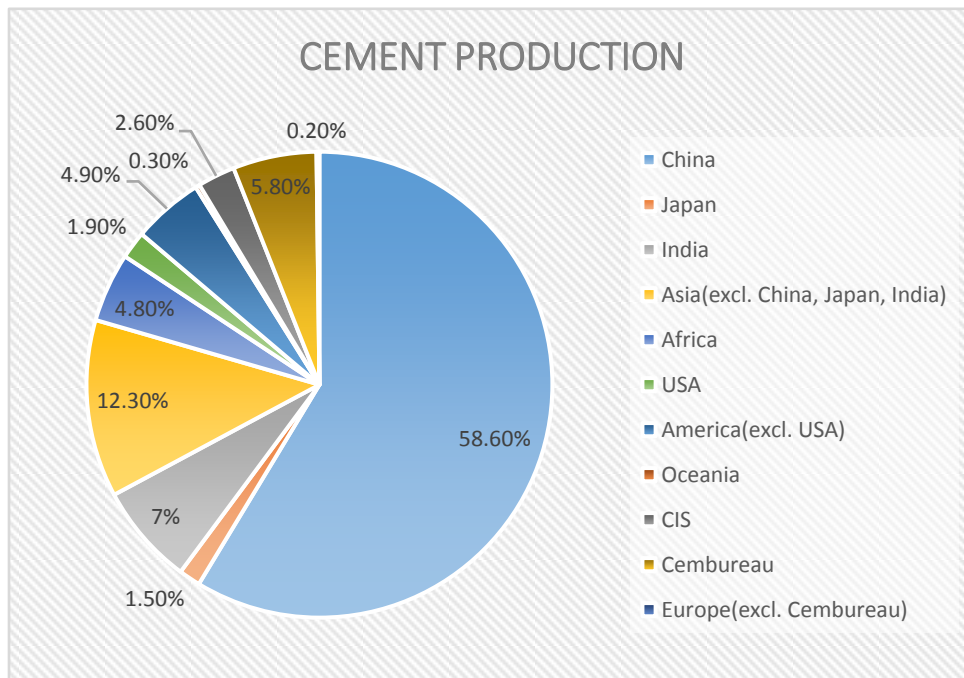
Keywords: Data Envelopment Analysis (Dea); Efficiency; Performance; Cement Industry.

Introduction

India is the second largest cement producer in the world. The industry is an energetic part, of its in economy, providing employment to more than a million people, directly or indirectly. Both, Indian and foreign investors are attracted to the Indian cement industry for investments.

It had a total cement manufacturing capacity of 375-390 million tonnes as of financial year 2014-15. The cement production capacity is estimated 550 million tonnes by FY2020. The housing sector is the largest demand consumer of cement, according for about two-thirds of total consumption. The other major consumers of cement include commercial construction, infrastructure and industrial construction. During the FY 2014-15, Indian’s cement industry grew by about 5.6% year on year as compared to 3.1% growth in the financial year 2013-14.

Figure 1: World cement production 2015 by region & main Countries 4 billion tonnes.(source: cma).



Global cement production has continued to increase 7.07% in the last five year from 2843 million tonnes in 2008 to 4000 million tonnes in 2015. The Indian cement industry has achieved second position in the world after China (source: cembureau

/ cma).

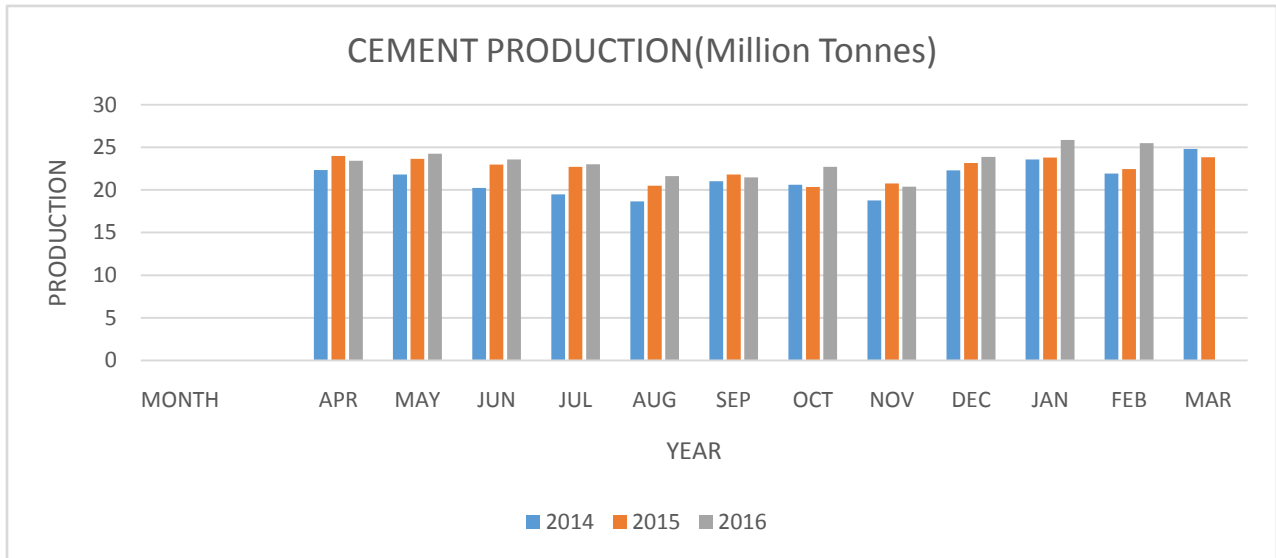


Figure 2: Source: cmaindia

Here, In India cement production decreased to 25.5 Million Tonnes in February from 25.88 Million Tonnes in January of 2016.

The Indian cement industry is controlled by a few numbers of companies. The 20% of the companies produces 70% of the cement. 188 large cement plants together produces 97 per cent of the total put in capacity in the country, with 365 small plants produce for the rest. 77 companies are located in the states of Andhra Pradesh, Rajasthan and Tamil Nadu. India is divided into main five regions which include northern, eastern, western, southern and central. The southern has the highest installed capacity and production as a maximum consumption. Andhra Pradesh, Tamil Nadu (both in southern region) and Rajasthan (northern region).

Cement demand is closely linked with overall economic growth, particularly the housing and infrastructure sector. The housing segment accounts for a major portion of the total domestic demand for cement in India. In the 12th Five Year Plan (2012-2015) of the Government, there is a strong focus on infrastructure development and the Government plans to increase investment in infrastructure to an amount of US\$ 1 trillion. The industry is expected to add a capacity of 150 MT during the Plan period.

The cement industry in India is globally competitive as the industry continues to observe positive movement such as cost control, continuous technology upgradation and increased construction activities. Major cement manufacturers in India are also increasingly using alternate fuels, particularly bioenergy, to fire their kilns. This is not only help in cutting down production costs of cement companies, but is also proving effective in reducing discharges. The raw materials of cement industry include limestone, slag, gypsum, fly ash, clinker. Increasing in industrial activities, real estate, construction and infrastructure, in addition to the commencement of various Special Economic Zones (SEZs) across the country, it remains a growing demand for cement. In this research paper used Data Envelopment Analysis (DEA) to measure the performance of selected cement companies in India.

The objective of this paper are to analyses the technical efficiency and scale efficiency of selected cement companies in India and compare the performance of these cement industries across the period of five years 2011 to 2015. 2016 data cannot be taken because Inputs and outputs of many companies were not available. This paper also identified scale as well as how to maximize profit and also identified factor where costs can be reduced.

Literature Review

The information to be used in this project is going to be provided by mainly looking at the company reports. The information about the cement industries to be collected for this project from Company’s annual reports 2011 to 2015. Some more information collected from the official website of particular cement industry.

DEA is used for the estimation of production limits, is a [nonparametric](#) method in [operations research](#) and [economics](#). It is used to observed measure [productive efficiency](#) of decision making units. Some more information was collected from Data envelopment analysis and performance management book which one edited by Ali Emrouznejad and Victor Podinivski.

According to, Canan saricam and Nazan Erdumlu (Istanbul Technical University, Turkey) (November 2012), this study

provides a framework for DEA application in determination and comparison of efficiency performance in an industry level. They research on evaluating efficiency level comparatively by DEA. They used DEA model for the study of show the usage of DEA in efficiency measurement. Here, it was analyzed by input oriented DEA model under variable return to scale assumption.

Dr.V.Sarangarajan, Dr.A.Ananth and Dr.S.A.Lourthuraj have observed that the cement industry performance was good in Tamil Nadu during 1997, 1998 and 2004, rest of the years the industry should improve their financial performance according to their research, on financial performance efficiency of selected cement companies in Tamil Nadu (January- April 2013). This research also helpful to us for making the project research on performance efficiency in cement industry. In this study they were used only cement company as random sample which one located in Tamil Nadu. Here they were conclude that the cement companies in Tamil Nadu have to combined in order to become strong, vibrant and also conclude that they have to concentrate on export market besides maintaining a good supply chain management strategy.

M. Haron and J.A. Arul chellakumar research on efficiency performance of manufacturing companies in Kenya (Summer 2012). Objective of paper is to determine the efficiency of manufacturing companies in Kenya over the period of 2009 to 2011 as well as to suggest appropriate policy to be employed by the manufacturing companies in Kenya. So using DEA model they the average overall technical efficiency score of large size, medium size and small size companies. At the end of this research they found that the small sized manufacturing companies are the best performing companies in term of relative efficiency. As per their opinion the result of this study provide a valuable reference for top manufacturing companies in Kenya in term of reviewing their efficiency level.

K. Bradley Watkins, Tatjana Hristovska, Ralph Mazzanti, Charles E. Wilson, Jr., and Lance Schmidt ((February 2014) research on measurement of technical, allocative, economic, and scale efficiency of rice production in Arkansas. DEA analysis is used to determine technical, allocative, and scale efficiency for fields enrolled for Rice Research Verification program in the University of Arkansas.

Charnes, A., Cooper, and W. Data Envelopment Analysis: Theory, Methodology and Applications also help to collect more and more information about the DEA and their methodology and application.

'DEA is a comparatively new method of "data oriented" which is used to estimation of performance of a set of examine units is called Decision Making Units (DMUs). It converts multiple inputs to multiple outputs'. Charnes, Cooper, and Rhodes (1978) described DEA is applied to observational data as a 'mathematical programming model, to provides a new way of obtaining observed estimates of relations - such as the production functions and/or efficient production possibility sides - that are bases of modern economics'.

DEA is an applied to turmeric production in North Western Region of Tamil Nadu (L. Mary Louis & A. John Joel) research paper also very helpful for preparing research project. According to L. Mary Louis and A. John (July-Sept 2010), the study was conducted with the data relate to 180 households, from 18 villages of Coimbatore and Erode districts in the northwestern region of Tamil Nadu. They was randomly selected three villages form each block. From the Agricultural Development office, a list of different villages located in 38 blocks of Coimbatore and Erode districts were obtained. They used software package GAMS (www.gams.com) has been used to analyze DEA. As per their opinion the model allowed an objective to measure the technical efficiency, which allowed ranking, classification, and a comparative study of sample turmeric farms. The technical inefficiency is there, might be due to lack of awareness, effective knowledge, expertise, attitude or inadequate resource supply required for the adoption of the technology.

METHODOLOGY

Here, DEA is used for computing the technical efficiency and scale efficiency scores of the cement manufacturing industries in India.

Data Envelopment Analysis: In DEA, efficiency is important factor to study, to find a relationship between inputs and outputs in a production process. DEA is used for the estimation of production limits is a [nonparametric](#) method in [operations research](#) and [economics](#). It is used to pragmatic measure [productive efficiency](#) of decision making units.

"The framework has been improved from multi-input and multi-output production functions. It is applied in many industries for measure performance efficiency. DEA identifies a "limits" which are characterized as an extreme point method that assumes that if a firm can produce a certain level of output made use of specific input levels, another firm of equal scale should be capable of doing the same.

Here, pooled data collection is used to study of performance efficiency in cement industry as manufacturing sector. The data used in study were collected for a period from 2010-2011 to 2014-2015 from the annual report made available by several organization. The present study consider twenty six cement industries. The following twenty six cement industries are taken for the study and they are Ambuja cement, Barak Valley cement, Binani cement, Burnpur cement, Chetnad cement, Dalmia Bhart cement, Deccan cement, Grasim Industries, Gujarat Sidhee cement, Heidelberg cement, Hyderabad industry, J.K. cement, J.K. Lakshmi cement, Kalyanpur cement, kesoram cement, Madras cement, Mangalam cement, Orrisa cement (OCL), Panyam cement, Prism cement, Sagar cement, Saurashtra cement, Shiva cement, The India cement, Trinetra cement, Ultratech cement etc.

Input-output variables have been selected by the company's annual reports and previous studies. In this study use four input variables and two output variables. Input variables are raw materials, employee benefits expense, other expenses and capital employed. Here other expenses include administration expense, manufacturing expenses, selling and distribution expenses while output variables are sale and other income.

DEA using the comparative efficiency concept, it is a one non-parameter statistical method for evaluating the same types of multi input and output decision making units (DMU) through efficiency or inefficiency. CCR-Model was introduced by Charnes, Cooper and Rhodes (1978). CCR model is based on the assumption of constant returns to scale; an efficiency margin is constructed to estimate the operational efficiency for DMU. Banker, Charnes and Cooper (1984) then developed the BCC model that extends the definition and applications of efficiency under the CCR model.

BCC model:

BCC model developed by Banker, Charnes and Cooper in 1984. The reason of inefficiency was disinvited into technological inefficiency and scale inefficiency (Banker et al., 1984), to which the CCR model added the convexity limitation of the linear combination, and reduced the BCC model to measure the pure technology efficiency, scale efficiency, and returns to scale. Here, present the BCC model as follow:

The model as applicable to ith DMU is present follow. Here DMU is known as cement Company.

Maximum Output X

Subject to: Output constraints

$$\sum_{n=1}^N X'_n \lambda_n - \alpha X'_i \geq 0 \quad \dots \dots \dots (1)$$

Input constraints

$$\sum_{n=1}^N Y'_n \lambda_n - \alpha Y'_i \leq 0 \quad \dots \dots \dots (2)$$

Here, $\lambda_n > 0$ for $n = 1, 2, 3 \dots N$ (3)

Where,

X' shows output parameters which can range from 1, 2, 3k outputs for N DMU's in the model.

Y' shows the input parameters which can range from 1, 2, 3....r input for N DMU's in the model.

X'_i shows the actual output of the ith DMU for each of the k output.

Y'_i shows the actual input of the ith DMU for each of the r input.

λ shows the Lagrange multiplier and in the solution it shows the efficient peer DMUs.

α show the factor by which the output of ith DMU can be expanded using the current level of input.

So, here set of parameters 1, 2, 3 are solved for overall Constant Return to scale technical efficiency $(CRS_{TE}) = \frac{1}{\alpha^*}$ under Constant Return to scale (CRS) assumption.

After that pure technical efficiency (VRS_{TE}) of DMU can be arrived at by relaxing CRS assumption and new α^* value α is compute by imposing additional parameters which presented in 4 to above existing parameter of 1 to 3.

$$\sum_{n=1}^N \lambda_n = 1 \quad \dots \dots \dots (4)$$

So, Scale efficiency of each DMU or Company is given by:

Scale efficiency (SE) = $\frac{\alpha^*}{\alpha}$ (5)

Here, α^* is CRS_{TE}

α is VRS_{TE}

So Scale efficiency (SE) = CRS_{TE} / VRS_{TE} .

If the DMUs are performing under the decreasing, increasing and constant return to scale the parameter previously mentioned 1 to 3 is solved for α^{**} with additional parameter 6 to reached at non increasing return to scale. ($NIRS_{TE} = \frac{1}{\alpha^{**}}$)

$$\sum_{n=1}^N \lambda_n \leq 1 \quad \dots \dots \dots (6)$$

The analysis of return on scale:

If the $NIRS_{TE}$ and VRS_{TE} are equal and 1 then constant return to scale exists. If the $NIRS_{TE}$ and VRS_{TE} are unequal than it shows the increasing return to scale. If $NIRS_{TE}$ and VRS_{TE} are equal and less than 1 then decreasing return to scale exists.

So, $NIRS_{TE} \neq VRS_{TE}$ then Increasing return to scale

$NIRS_{TE} = VRS_{TE}$ then Decreasing return to scale.

The solution to the VRS and CRS model provide minimum level of input and maximum level of output which the company produce. The excess of actual input consumption over the minimum level required for production is the input slack with respect to each input. Similarly the excess of maximum output over the actual output, gives the output slack with respect to each of the output. The output slack represent the extra revenue that can be generated. The input slack represent costs which the DMU (company) can saved. Capital slack shows the excess capital employed in the company. Here it is assumed that the company which have the capital employed slack will saved interest cost by reducing the capital employed. This has been arrived at follows:

Cost of Borrowing = Interest for the year / Average capital employed (7)

Interest Saving = Cost of borrowing * Capital employed Slack (8)

The maximum possible profit for the inefficient company is arrived at by combining the possible cost saving in each of the inputs and interest costs with the current profit before tax of the company.

Results and conclusion

Sample Size and data collection:

These project research used the financial data of 26 cement operating companies in India. The analysis is done from the period for year 2011 to 2015. 2016 data cannot be taken because Inputs and outputs of many companies were not available. Here sales include the sales of cement, clinker, power and other. The other income is another output of cement industries. Input include raw material, employee benefits expenses, other expenses and capital employed. In other expenses cover the expenses related to the administration, sales and distribution and other manufacturing expenses. The data include various input and output. It is written in the form of liner programming formulas. Then this equations are solved using DEA technique.

The result for cement manufacturing companies are shown in table 1. The constant return to scale (CRS) shows that the manufacturing company has got the best scale. If the output increased by less than that proportional change in input is shows decreasing scale and the increasing return to scale indicates that the output increase by more than that proportional change in input. Generally, If DMU obtains a score of 1 than it consider to be efficient, whereas a score of less than 1 shows that it is relatively inefficient.

In this paper the DEA efficiency calculated for the year 2011 to 2015 for each companies. The data of efficiency score given in the table 1 DEA efficiency statement for the cement companies. Based on the DEA score and analysis the companies can be classified in 4 types namely:

Efficient companies:

Efficient companies are companies that have presented no inefficiency across the time period the study. If the companies have DEA score 1 than it's efficient. So the efficient company have efficiency score equal to 1. This shows that these companies are utilizing ideal input resources and producing the maximum possible output.

Inefficient companies:

Inefficient companies are companies that have inefficiency across the panel period the study. Inefficient company have DEA score 1. The companies, which are operating under increasing return to scale can increase profitability by increasing the scale of production. The companies operating under decreasing return to scale are over utilizing resources so, it inefficient.

YEAR	Efficient company	Inefficient Company
2011	18	7
2012	21	4
2013	20	5
2014	21	4
2015	22	3

TABLE (A): Number of efficient and inefficient companies as per Table 1

As per the scale efficiency score efficient and inefficient cement companies are distributed. Here, if the companies DEA score is 1 than it's include in efficient company. Here if the DEA or scale efficiency score is equal 1 or if DEA score is 0.95 or more than 0.95 those all the companies are included as efficient companies. If the Scale efficiency score is less then1 or less than 0.95 those all the companies are included in the inefficient companies.

So, here as per DEA analysis 18, 21, 20, 21 and 22 companies are efficient in year 2011, 2012, 2013, 2014 and 2015 respectively. As well as 7,4,5,4 and 3 companies are inefficient in year 2011 to 2015 respectively in this list as per table 1 data.

Declining efficiency:

Declining efficiency include that companies whose overall technical efficiency has fallen in 2015 when compared with previous four years 2011, 2012, 2013 and 2014.

Improving efficiency:

Improving efficiency include that company whose overall technical efficiency has improved in 2015 when its compere with previous year 2011, 2012, 2013 and 2014. Improving efficiency Company improving their profit or performance and reducing inefficiencies.

Table 2 is showing maximum possible improvement in profit for the different year. The maximum possible improvement in profit have been calculated for the different years with possible percentage improvement in profit based on slack obtain from CRS and VRS solution. Table 2 is for profitability statement for VRS and Table 3 is for profitability statement CRS. These both tables shows the maximum possible profit with percentage. On the basis of VRS and CRS profitability statement following conclusion can be drawn:

Companies can saved input like raw material, employee benefit expenses and other expenses without reducing their output.

As per VRS profitability statement most of the inefficient companies are over expenses on employee benefits cost and also over cost in other expenses. They have utilized more expense than necessary. The India Cement company is top of the list with an excess expense in employee benefits expense of RS. 93.07 crores in year 2015 across the 5 years. So this is also one reason for company reduce their profit.

As per CRS profitability statement most of the inefficient companies are over expenses on capital employed or over capitalized and have utilized more than necessary capital. As per the CRS profitability statement Sagar cement company top the list with RS.521.3 crores excess capital used in year 2015 across the 5 years.

As per the VRS profitability statement most companies are performing efficiently with respect to consumption of raw material. But as per the CRS profitability statement some cement companies like Binai, Sagar, Burnpur, Shiva, Prism and Kesoram Cement are performing inefficiently with respect to consumption of raw material.

So here table 2 VRS profitability statement and table 3 CRS profitability statement shows how to companies maximize their profit by using minimum input. Overall by minimizing the consumption of resources like raw material, employee benefit cost, other expenses and capital the inefficient companies improved their profits in 2015.

In VRS and CRS profitability statement analysis some companies are loss making companies but if that company reduce their excess use inputs than they reduce the loss and maximize their profits.

Following table B shows those company who are loss making and those companies also in table 2 and table 3 which one denoted by *.

YEAR	COMPANY NAME	OUTPUT		INPUT				IS	PBT	MPP	% CHANGE
		SALES	OTHER INCOME	RM	EB	OE	CE				
2011	GUJARAT SIDHEE*		1.606			-9.468			-6.04	5.034	-183.34%
2012	BARAK VALLEY*		57.42		-2.256				-6.52	53.16	-915.34%
	TRINETRA *		49.93				-285.6	-15.3	-41.81	293.69	-802.45%
2013	BARAK VALLEY*		56.72		-0.207				-0.38	56.549	-14981.30%
	HEIDELBERG*				-11.72				-80.67	-68.95	-14.53%
	TRINETRA *		93.53				-390.6	-47.5	-5.72	478.44	-8464.39%
2014	BARAK VALLEY*		37.23						-0.85	36.381	-4380.13%
	SAGAR *						-26.81	-1.82	-37.35	-10.54	-71.79%
	TRINETRA*		6.232				-106.4	-8.45	-43.61	68.981	-258.18%
2015	BINANI *					-96.59	-113.4	-16	-147.32	62.715	-142.57%
	GUJARAT SIDHEE*					-1.433			-6.8	-5.367	-21.07%
	TRINETRA *		10.98				-10.38	-0.54	-24.18	-2.822	-88.33%

TABLE B: list of the loss making companies as per VRS profitability statement

Table B shows the list of loss making companies as per profitability statement of VRS. This table highlights those Cement Company which one making loss but if they reduce excess capital or other excess expenses like employee benefits expenses and other expense than it reduce their loss and maximize their profit. Here as per VRS profitability Barak valley cement is improved their profit in 2015 as compare to year 2012. As per the VRA profitability statement Trinetra Cement Company are over capitalized and have used more capital than necessary. In 2012 they used RS. 285.6 crores used more than necessary capital. After that they reduce the over capitalization year and year reduce their loss in year 2015.

YEAR	COMPANY NAME	OUTPUT		INPUT				IS	PBT	MPP	% CHANGE
		SALES	OTHER INCOME	RM	EB	OE	CE				
2011	GUJARAT SIDHEE*		1.898			-8.4033			-6.04	4.2609	-170.55%
2012	BARAK VALLEY *		2.88						-6.52	-3.64	-44.18%
	PRISM *		46.75						-45.99	0.7641	-101.66%
	TRINETRA*		15.79				-247.2	-13.23	-41.81	221.21	-629.09%
2013	BARAK VALLEY*		2.138						-0.38	1.7584	-562.74%
	PRISM *		72.43						-82.99	-10.56	-87.28%
	TRINETRA*		16.96				-280.8	-34.12	-5.72	292.01	-5205.11%
2014	BARAK VALLEY*		2.93						-0.85	2.0801	-344.72%
	BINANI *			-101.96		-112.32	-199.2	-32.37	-293.4	120.12	-140.95%
	SAGAR *			-52.28	-25.31	-408.85	-240.9	-16.33	-37.35	689.96	-1947.28%
	TRINETRA*		10.01				-130.4	-10.36	-43.61	96.834	-322.05%
2015	BINANI *					-91.211	-90.13	-12.73	-147.32	34.02	-123.09%
	KESORAM*		26.33	-1038.8					-366.7	698.41	-290.47%
	PRISM *		117	-456.69					-10.75	562.94	-5336.64%
	TRINETRA*		14.15				-37.9	-1.977	-24.18	27.874	-215.28%

TABLE C: list of the loss making companies as per CRS profitability statement

Table C shows the list of loss making companies as per profitability statement of CRS. This table highlights those Cement Company which one making loss but if they reduce excess capital or other excess expenses like employee benefits expenses and other expense than it reduce their loss and maximize their profit. Here as per CRS profitability Barak valley cement is improved their profit in 2015 as compare to year 2012. As per the CRS profitability statement Trinetra Cement Company are over capitalized and have used more capital than necessary. In 2012 they used RS. 247.2 crores used more than necessary capital. After that they reduce the over capitalization year and year reduce their loss in year 2015.

Table 1: DEA Efficiency Statement for Cement Companies 2011 to 2015

COMPANY	2011				2012				2013				2014				2015			
	VRS TE	CRS TE	SE	RTS	VRS TE	CRS TE	SE	RTS	VRS TE	CRS TE	SE	RTS	VRS TE	CRS TE	SE	RTS	VRS TE	CRS TE	SE	RTS
AMBUJA	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
BARAK VALLEY	0.66	0.62	0.94	IRS	0.82	0.6	0.73	IRS	0.93	0.65	0.7	IRS	0.92	0.67	0.73	IRS	0.8	0.67	0.84	IRS
BINANI	0.86	0.81	0.94	DRS	0.73	0.73	1	DRS	0.8	0.79	0.99	DRS	1	0.88	0.88	CRS	0.83	0.82	1	IRS
BURNPUR	1	0.9	0.9	IRS	1	0.9	0.9	IRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
CHETINAD	0.99	0.95	0.96	DRS	0.82	0.82	1	DRS	0.79	0.78	0.98	DRS	0.89	0.89	0.99	DRS	0.91	0.9	0.99	DRS
DALMIA BHART	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
DECCAN	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
GRASIM	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
GUJARAT SIDHEE	0.77	0.77	1	DRS	0.79	0.79	1	DRS	0.82	0.79	0.96	IRS	0.82	0.81	0.99	IRS	0.8	0.79	0.99	DRS
HEIDELBERG	0.64	0.62	0.97	DRS	0.61	0.6	0.98	DRS	0.65	0.64	0.98	DRS	0.66	0.66	0.99	DRS	0.64	0.63	0.99	IRS
HYDERABAD	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
J.K.CEMENT	0.78	0.68	0.87	DRS	0.75	0.73	0.98	DRS	0.73	0.71	0.98	DRS	0.71	0.71	0.99	DRS	0.74	0.73	0.99	DRS
JK LAKHSMI	0.69	0.66	0.96	DRS	0.71	0.7	0.98	DRS	0.69	0.77	1.12	IRS	0.8	0.79	0.99	DRS	0.78	0.77	0.99	DRS
KALYANPUR	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
KESORAM	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	0.87	0.87	CRS
MADRAS CEMENT	0.84	0.74	0.88	DRS	0.81	0.77	0.94	DRS	0.81	0.74	0.9	DRS	0.76	0.71	0.94	DRS	0.72	0.71	0.99	DRS
MANGALAM	0.65	0.63	0.98	DRS	0.7	0.69	0.99	IRS	0.66	0.65	0.97	IRS	0.71	0.69	0.98	IRS	0.71	0.71	1	DRS
ORISSA	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	0.97	0.97	1	DRS	1	1	1	CRS
PANYAM	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
PRISM	1	0.97	0.97	CRS	1	0.95	0.95	CRS	1	0.94	0.94	CRS	1	0.99	0.99	CRS	1	0.97	0.97	CRS
SAGAR	0.72	####	####	DRS	0.83	####	####	DRS	0.77	####	####	DRS	0.75	####	####	DRS	1	####	####	CRS
SAURASHTRA	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
SHIVA	1	0.92	0.92	IRS	1	0.97	0.97	IRS	1	1	1	CRS	1	1	1	CRS	1	0.98	0.98	IRS
THE INDIA	0.8	0.6	0.75	DRS	0.82	0.66	0.81	DRS	0.96	0.65	0.68	DRS	1	0.67	0.67	CRS	0.96	0.7	0.73	DRS
TRINETRA	1	1	1	CRS	0.66	0.62	0.95	IRS	0.75	0.68	0.9	IRS	0.71	0.69	0.97	IRS	0.67	0.66	0.99	IRS
ULTRATECH	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS	1	1	1	CRS
MEAN	0.90	0.87	0.96		0.89	0.86	0.97		0.90	0.87	0.96		0.91	0.89	0.96		0.91	0.88	0.97	

NOTE:

VRS TE: Total efficiency of variable return to scale

CRS TE: Total efficiency of constant return to scale

SE: Scale efficiency

RTS: Return to scale

CRS: Constant return to scale

IRS: Increasing return to scale

DCR: Decreasing return to scale

###: it's failed to find result of scale efficiency. As per the data of Sagar Cement DEA solver not find sufficient solution of scale

efficiency. So, it is denoted or presented by ###.

**Table 2: PROFITABILITY STATEMENT VRS
(RS IN CRORE)**

YEAR	COMPANY NAME	OUTPUT		INPUT				IS	PBT	MPP	% CHANGE
		SALES	OTHER INCOME	RM	EB	OE	CE				
VRS 2011	BARAK VALLEY		1.702		-1.815				0.56	4.0771	628.05%
	BINANI		110.6		-1.663	-78.89			82.27	273.38	232.29%
	CHETINAD		2.834		-13.64				95.07	111.54	17.32%
	HEIDELBERG		12.95						42.36	55.306	30.56%
	J.K.CEMENT		97.74		-46.21	-86.13			83.68	313.76	274.95%
	JK LAKHSMI		28.08		-7.943				78.79	114.81	45.72%
	MADRAS		86.97		-37.03				297.26	421.26	41.71%
	THE INDIA				-61.02	-643.7			89.87	794.62	784.19%
	GUJARAT SIDHEE*		1.606			-9.468			-6.04	5.034	-183.34%
VRS 2012	BINANI		30.33		-4.214				53.15	87.691	64.99%
	CHETINAD		61.81		-32.83				251.20	345.84	37.68%
	GUJARAT SIDHEE		7.164						11.69	18.854	61.28%
	HEIDELBERG		23.25		-14.02				45.66	82.931	81.63%
	J.K.CEMENT		35.52		-52.09				285.79	373.4	30.65%
	JK LAKHSMI				-24.12				142.74	166.86	16.90%
	MADRAS CEMENT		56.67		-48.81				557.42	662.91	18.92%
	MANGALAM		59.32						74.94	134.26	79.16%
	SAGAR		0.315						64.6	64.915	0.49%
	THE INDIA				-54.18	-408.5			380.98	843.65	121.44%
	BARAK VALLEY*		57.42		-2.256				-6.52	53.16	-915.34%
	TRINETRA *		49.93				-285.6	-15.3	-41.81	293.69	-802.45%
VRS 2013	BINANI			-11.49		-13.27	-205.4	-36.1	155.00	385.14	148.48%
	CHETINAD		66.2		-21.3				157.22	244.71	55.65%
	GUJARAT SIDHEE		48.28				-5.556	-1.58	57.85	111.69	93.07%
	J.K.CEMENT		32.02		-46.35	-19.44			340.63	438.44	28.72%
	JK LAKHSMI		28.08		-7.943				235.36	271.38	15.31%
	MADRAS CEMENT		3.003		-45.16	-279.6			588.21	915.92	55.71%
	MANGALAM		70.26						107.81	178.07	65.17%
	SAGAR		4.008				-71.7	-6.02	10.92	86.631	693.33%
	THE INDIA				-71.52	-922.1			252.36	1246	393.74%
	BARAK VALLEY*		56.72		-0.207				-0.38	56.549	-14981.30%
	HEIDELBERG*				-11.72				-80.67	-68.95	-14.53%

TRINETRA ***93.53****-390.6****-47.5****-5.72****478.44****-8464.39%****Table 2: PROFITABILITY STATEMENT VRS CONTINUE****(RS****IN CRORE)**

YEAR	COMPANY NAME	OUTPUT		INPUT				IS	PBT	MPP	% CHANGE	
		SALES	OTHER INCOME	RM	EB	OE	CE					
VRS 2014	CHETINAD		80.57		-8.796				105.99	195.36	84.32%	
	GUJARAT SIDHEE		13.59						0.41	14	3314.73%	
	HEIDELBERG		9.725						59.9	69.625	16.23%	
	J.K.CEMENT		43.75		-37.89				136.27	217.91	59.91%	
	JK LAKHSMI		22.81		-7.55				115.37	145.73	26.32%	
	MADRAS CEMENT				-11.42				154.34	165.76	7.40%	
	MANGALAM		42.76						23.93	66.687	178.67%	
	ORISSA		7.246						133.08	140.33	5.44%	
	BARAK VALLEY*		37.23						-0.85	36.381	-4380.13%	
	SAGAR *						-26.81	-1.82	-37.35	-10.54	-71.79%	
	TRINETRA *		6.232				-106.4	-8.45	-43.61	68.981	-258.18%	
VRS 2015	BARAK VALLEY		80.75						3.57	84.325	2262.03%	
	CHETINAD		113.2		-7.245				257.18	377.64	46.84%	
	HEIDELBERG		74.22						59.9	134.12	123.90%	
	J.K.CEMENT		75.81		-62.72				159.15	297.68	87.04%	
	JK LAKHSMI		64.46		-27.78				111.77	204.02	82.53%	
	MADRAS CEMENT				-46.32				356.43	402.75	13.00%	
	MANGALAM		14.38						18.99	33.365	75.70%	
	THE INDIA				-206.5	-93.07	-746.6		29.45	1075.6	3552.34%	
	BINANI *						-96.59	-113.4	-16	-147.32	62.715	-142.57%
	GUJARAT SIDHEE*						-1.433		-6.8	-5.367	-21.07%	
	TRINETRA *		10.98				-10.38	-0.54	-24.18	-2.822	-88.33%	

NOTE:**RM: RAW MATERIAL****EB: EMPLOYEE BENEFITS EXPENSES****OE: OTHER EXPENSES****CE: CAPITAL EMPLOYED****IS: INTEREST SAVED****PBT: PROFIT BEFORE TAX**

MPP: MAXIMUM POSSIBLE PROFIT

*: LOSS MAKING COMPANY MINIMIZE THEIR LOSS

TABLE 3: PROFITABILITY STATEMENT CRS
(RS IN CRORE)

YEAR	COMPANY NAME	OUTPUT		INPUT				IS	PBT	MPP	% CHANGE	
		SALES	OTHER INCOME	RM	EB	OE	CE					
CRS 2011	BARAK VALLEY		1.849						0.56	2.4091	330.20%	
	BINANI		116						82.27	198.23	140.95%	
	BURNPUR		0.714	-10.106				-53.77	-0.222	0.79	65.385	8176.61%
	J.K.CEMENT				-12.01					83.68	95.689	14.35%
	MADRAS		2.837						297.26	300.1	0.95%	
	MANGALAM		1.805						41.37	43.175	4.36%	
	PRISM		32.16						130.66	162.82	24.61%	
	SAGAR			-49.64	-18.38	-307.33	-221.7	-19.47	22.7	619.7	2629.96%	
	SHIVA		0.842	-17.387				-21.02	-3.56	3.38	42.625	1161.10%
	THE INDIA				-35.38					89.87	125.25	39.37%
	GUJARAT SIDHEE*			1.898				-8.4033		-6.04	4.2609	-170.55%
CRS 2012	BINANI		29.76						53.15	82.907	55.99%	
	BURNPUR		1.385	-16.412				-51.63	-0.096	1.51	70.937	4597.81%
	CHETINAD		58.92						251.20	310.12	23.46%	
	GUJARAT SIDHEE		2.024						11.69	13.714	17.31%	
	HEIDELBERG		22.13						45.66	67.788	48.46%	
	J.K.CEMENT		25.91						285.79	311.7	9.07%	
	JK LAKHSMI				-4.052				142.74	146.79	2.84%	
	MADRAS		51.66						557.42	609.08	9.27%	
	MANGALAM		4.907						74.94	79.847	6.55%	
	SAGAR			-54.02	-26.56	-388.63	-259.7	-28	64.6	793.51	1128.34%	
	SHIVA		1.257	-26.285				-32.51	-7.849	3.04	63.091	1975.36%
	BARAK VALLEY *			2.88						-6.52	-3.64	-44.18%
	PRISM *			46.75						-45.99	0.7641	-101.66%
	TRINETRA*			15.79				-247.2	-13.23	-41.81	221.21	-629.09%
CRA 2013	BINANI						-193.6	-33.99	155.00	348.6	124.91%	
	CHETINAD		61.07						157.22	218.29	38.84%	
	GUJARAT SIDHEE		4.105		-1.316				57.85	63.271	9.37%	
	J.K.CEMENT		24.35		-31.21				340.63	396.19	16.31%	
	MADRAS		8.317		-33.76				588.21	630.29	7.15%	

MANGALAM		4.616		-5.449				107.81	117.88	9.34%	
SAGAR			-53.86	-23.03	-433.78	-266.5	-22.37	10.92	788.04	7116.48%	
BARAK VALLEY*		2.138						-0.38	1.7584	-562.74%	
PRISM *		72.43						-82.99	-10.56	-87.28%	
TRINETRA*		16.96					-280.8	-34.12	-5.72	292.01	-5205.11%

TABLE 3: PROFITABILITY STATEMENT CRS CONTINUE.....

(RS

IN CRORE)

YEAR	COMPANY NAME	OUTPUT		INPUT				IS	PBT	MPP	% CHANGE	
		SALES	OTHER INCOME	RM	EB	OE	CE					
CRS 2014	CHETINAD		78.14						105.99	184.13	73.72%	
	HEIDELBERG		10.98						59.9	70.885	18.34%	
	JK LAKHSMI		20.22						115.37	135.59	17.52%	
	MANGALAM		8.737						23.93	32.667	36.51%	
	ORISSA		7.838						133.08	140.92	5.89%	
	BARAK VALLEY*		2.93						-0.85	2.0801	-344.72%	
	BINANI *				-101.96		-112.32	-199.2	-32.37	-293.4	120.12	-140.95%
	SAGAR *				-52.28	-25.31	-408.85	-240.9	-16.33	-37.35	689.96	-1947.28%
	TRINETRA*		10.01					-130.4	-10.36	-43.61	96.834	-322.05%
CRS 2015	BARAK VALLEY		4.707						3.57	8.2775	131.86%	
	CHETINAD		70.3						257.18	327.48	27.33%	
	HEIDELBERG		18.46						59.9	78.365	30.83%	
	J.K.CEMENT		37.75						159.15	196.9	23.72%	
	JK LAKHSMI		59.45						111.77	171.22	53.19%	
	MANGALAM		17.01						18.99	36.003	89.59%	
	SAGAR				-67.78		-428.28	-521.3	-55.35	378.3	1395.7	268.94%
	SHIVA		1.677	-12.524					2.76	16.961	514.53%	
	BINANI *						-91.211	-90.13	-12.73	-147.32	34.02	-123.09%
	KESORAM*		26.33	-1038.8					-366.7	698.41	-290.47%	
PRISM *		117	-456.69					-10.75	562.94	-5336.64%		
TRINETRA*		14.15					-37.9	-1.977	-24.18	27.874	-215.28%	

NOTE:

RM: RAW MATERIAL

EB: EMPLOYEE BENEFITS EXPENSES

OE: OTHER EXPENSES

CE: CAPITAL EMPLOYED

IS: INTEREST SAVED

PBT: PROFIT BEFORE TAX

MPP: MAXIMUM POSSIBLE PROFIT

***: LOSS MAKING COMPANY MINIMIZE THEIR LOSS**

The following conclusion can be given from an analysis of the year wise profitability and efficiency of the companies:

The year wise MEAN of the efficiency scores actually disclose that the overall technical efficiency of the sector remained in year 2012 at 0.86 as compare to 2011 at 0.87. But in the year 2014, the overall technical efficiency of the sector has improved to 0.88 as compared to year 2011, 2012, 2013 and 2014. Additional both scale and pure technical efficiency also show improvement over the previous year.

Through the DEA analysis following average efficiency score found for the year 2011 to 2015.

AVERAGE EFFICIENCY SCORES 2011 TO 2015					
	2011	2012	2013	2014	2015
TC VRS	0.9	0.89	0.9	0.91	0.91
TC CRS	0.87	0.86	0.87	0.89	0.88
SE	0.96	0.97	0.96	0.96	0.97

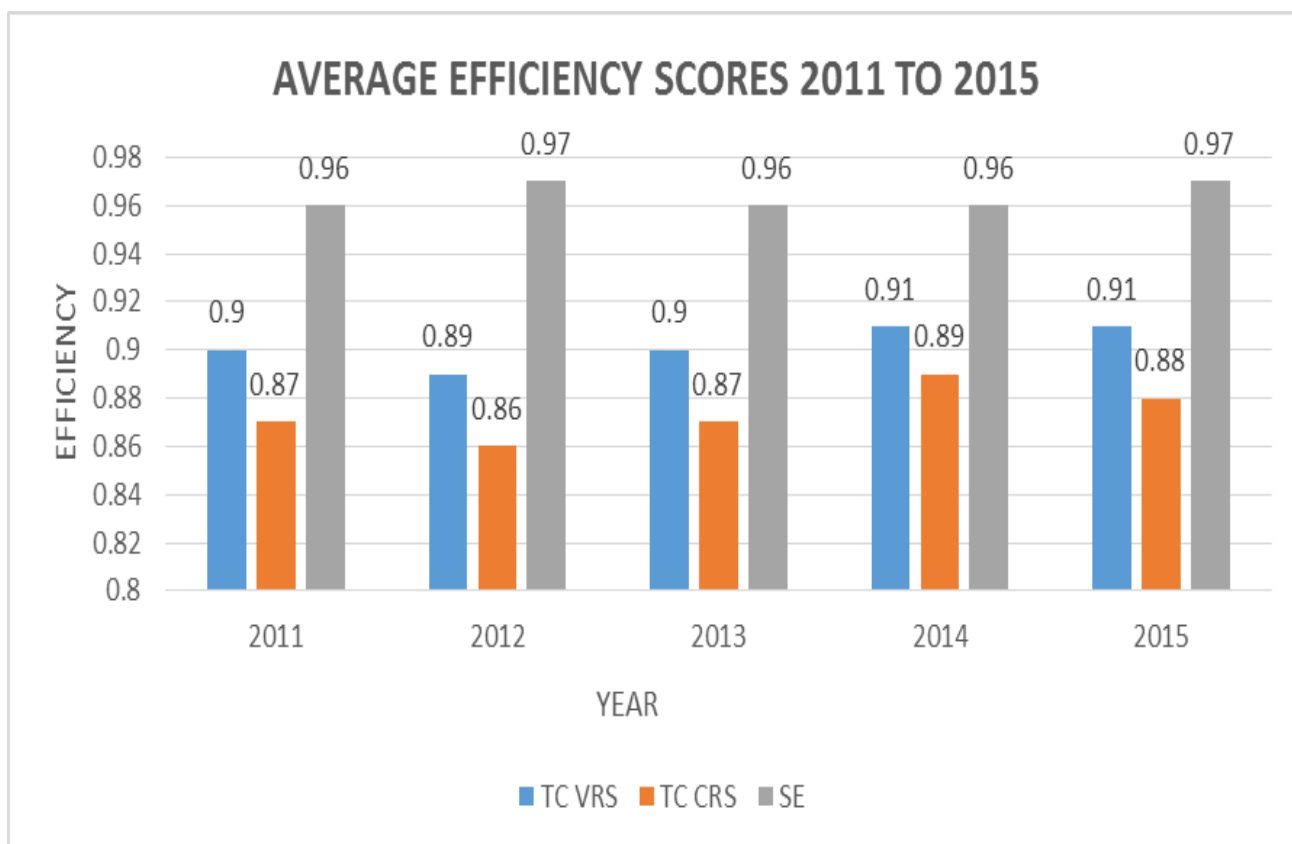


Figure 3

Conclusion

Cement demand is closely linked with overall economic growth, particularly the housing and infrastructure sector. The housing segment accounts for a major portion of the total domestic demand for cement in India. The efficiency of cement companies are analyzed in this paper.

This study is made to investigate the technical as well as scale efficiency of cement companies in India over the period of 2011 to 2015. The BCC model have been used to obtain the various efficiency scores for 26 cement companies (DMUs).

Figure 3 shows the chart of average efficiency score 2011 to 2015. The efficiency chart in figure 3 shows that the MEAN scale

efficiency improved from 2011 to 2012. After that MEAN scale efficiency remain unchanged in 2013 and 2014. After that it improved in 2015. In the pure technical and overall technical efficiency both decline in year 2011 to 2012 than after both are improve in 2013 to 2015.

After the study of DEA analysis the result shows following numbers of efficient and inefficient cement companies.

YEAR	Efficient company	Inefficient Company
2011	18	7
2012	21	4
2013	20	5
2014	21	4
2015	22	3

The result shows the cement companies perform more efficiently in 2015 as compare to previous year 2011 to 2014 and also reduce inefficiency in performance in 2015 as compare to 2011 to 2015.

REFERENCES

1. Canan Saricam, Nazan Erdumlu, *Evaluating efficiency levels comparatively: data envelopment analysis application for Turkish textile and apparel industry. Journal of Industrial Engineering and Management JIEM, 2012 – 5(2): 518-531 – Online ISSN: 2013-0953 – Print ISSN: 2013-8423 <http://dx.doi.org/10.3926/jiem.560>*
2. M. Haron, 2 J. A. Arul Chellakumar, *Efficiency Performance of Manufacturing Companies in Kenya: Evaluation and Policies Department of Economics, Commerce and Financial Studies, Bharathidasan University Tamil Nadu, India, Int. J. Manag. Bus. Res., 2 (3), 233- 242, Summer 2012 © IAU*
3. K. Bradley Watkins, Tatjana Hristovska, Ralph Mazzanti, Charles E. Wilson, Jr., and Lance Schmidt, *Measurement of Technical, Allocative, Economic, and Scale Efficiency of Rice Production in Arkansas Using Data Envelopment Analysis, Journal of Agricultural and Applied Economics, 46,1(February 2014):89–106 2014 Southern Agricultural Economics Association*
4. Charnes, A., Cooper, W. *Data Envelopment Analysis: Theory, Methodology and Applications. ISBN 0-7923-9480-1.*
5. Latha Chari, Nandkishor Patil, Dr. R.P. Mohanty, *Assessment of Technical and Scale Efficiencies of Indian Cement Industry Using Data Envelopment Analysis (DEA), Volumn-11 & Issue No.4 Oct.-2009 Industrial Engineering Journal.*
6. L. Mary Louis & A. John Joel, *Data envelopment analysis—an application to turmeric production in North Western Region of Tamil Nadu, Accepted: 2 November 2010 /Published online: 24 November 2010 # Operational Research Society of India 2011*
7. DEA Wikipedia.com