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# Performance of Intellectual Capital Management of Indian Public Sector Enterprises

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**Abstract** Intellectual capital is most vital enabler of enterprises. Managing intellectual capital effectively can greatly enhance the competitive advantages of any enterprises. This study focused on how the enterprises utilize intellectual capital, in order to strengthen the competitiveness of enterprises. This research established a novel assessment model to measure the performance of intellectual capital management. The research target is the Indian Public Sector Enterprises (PSE). The research collected data from the Annual Report of PSEs listed in Bombay Stock Exchange for the period 2001-02 to 2010-11. A total of 50 companies randomly selected amongst Indian Public Sector Enterprises and were chosen as empirical samples. The results demonstrated that, this novel assessment method really identify the relative advantages and benchmarking for Indian Public Sector Enterprises. The best company is chosen both in operational performance and productivity improvement. This model is a performance assessment model to judge Intellectual Capital along with Financial Capital.
**Keywords** Intellectual Capital, Knowledge Management, Indian Public Sector Enterprises, Data Envelopment Analysis, Grey Relational Analysis, Malmquist Productivity Index.

## 1 Introduction

By the end of the Second World War in 1945, most agriculture-based economies in Europe and North America had transformed into manufacturing economies, changing the focus from land and labour to financial and physical capital. Today, world economies are moving from manufacturing toward knowledge-based economic activity. Drucker (1993) indicates that knowledge is the only meaningful factor of production that is superior to land, labour, and capital. He adds that the unique contribution of management in the 20th century was the 50-fold increase in the manual worker's productivity through the conversion of labour-intensive economies into manufacturing economies. In the 21st century, management has contributed to the increase in productivity of the knowledge worker and a shift from production equipment to knowledge work. This is why many firms and even countries are planning strategies to reposition themselves in the emerging knowledge economy. In the current era of the knowledge economy, business resources comprise 20% tangible assets and 80% that are intangibles. The corporate performance measurement system, however, dates back to the manufacturing era, and are heavily inclined toward financial and physical aspects, lacking relevant information on the performance of intellectual capital (IC) or knowledge capital (KC). Thus, different ways of monitoring operations are needed to achieve maximum

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productivity from companies' intangible resources. There have been many attempts to define the term IC. Edvinson and Malone (1997) said IC as "knowledge that can be converted into value."

Economic managers in many countries feel that the transformation of production-based economies to knowledge-based economies is inevitable if they are to maintain the pace of economic development. According to Pulic (2000), IC is a moving force for business success. Seeing the growing importance to prepare for the challenges of the knowledge economy in the globalization era, the Government of India has constituted National Knowledge Commission under the chairmanship of Sam Pitroda. It is expected that the recommendations of the commission will ultimately facilitate far-reaching changes in the field of governance, education and research. To quote the chairman of the commission, "We are planting the seeds that will produce results within 20 years." In a knowledge economy, IC is considered crucial to the competitiveness of many companies, regardless of which industry they belong to. A sample of 50 companies listed in BSE-PSU are selected keeping in view that most companies with vast intellectual capital management (ICM) experience are large organizations of India have potential to become large scale organizations of the world. BSE-PSU represents a range of industries, making it easier to generalize the findings.

This research focuses on the firm's Intellectual Capital Performance management using the Value Added Intellectual Coefficient (VAIC). The VAIC has become very popular due to its straightforward calculations, availability of reliable audited data, and easy comparison across various industrial sectors (Pulic 2004). This method provides a standardized and straightforward measure of calculating and comparing IC performance across various sectors at national and international levels. The method uses publicly available audited information, which is more reliable and more usable by internal and external stakeholders to check IC efficiency. The VAIC-based view of the firm gives a better insight into viewing a firm's value-creation efficiency using different IC resources. Using the VAIC index, this paper examines the ranking of organization based on Grey Relation Analysis and Malmquist Productivity Index. The study is quantitative and based on ten-year data from 2001-02 to 20010-11, gathered from the audited annual reports of BSE-PSU companies. Companies in the sample cover more than seven industrial sectors, making the sample representative.

In the developed world, the term IC is widely used by the research community. Pulic (2000) used VAIC to analyze and measure the performance of FTSE-250 companies under the London Stock Exchange. Kujansivu and Lonnqvist (2007) utilized a subordinate concept of VAIC and intellectual capital efficiency (ICE) to analyze the IC performance of companies covering the 11 largest industries of Finland. Other studies that relate to the IC disclosure of FTSE-100 and S&P-500 companies were conducted by Williams (2001) and Robert (2000), respectively. Mavridis (2004), Goh (2005), and Kamath (2007) use VAIC to analyze the performance of Japanese, Malaysian, and Indian banks, respectively, and find significant differences in IC performance.

## 2 The data

The research collected data from the Annual Report of PSEs listed in Bombay Stock Exchange for the period 2001-02 to 2010-11. A total of 50 companies randomly selected amongst Indian Public Sector Enterprises and were chosen as empirical samples.

## 3 The models

### 3.1 VAIC (Value Added Intellectual Coefficient) model

The VAIC used in this study is introduced by Pulic (1998). It provides a new way of measuring value creation efficiency in companies using data available in financial statements. VAIC is designed to effectively evaluate the efficiency in adding value (VA) to a firm, focusing on value addition in an organization and not on cost control (Pulic 2000). The VAIC is based on the following five calculations:

(i). VA = OUT – IN where VA is the value addition from current year resources. Out = total sales and In = cost of materials, components, and services. Alternatively, value added can be calculated as: = OP + EC + D + A where OP = operating profit, EC = employee cost, D = depreciation, and A = amortization.

(ii). CEE = VA/CE where CEE is the capital employed efficiency of the firm and CE = capital employed (net book value of total assets).

(iii). HCE = VA/HC where HCE is the human capital efficiency of the firm and HC = total salaries and wages (direct labor + indirect labor + administration, marketing, and selling salaries).

(iv). SCE = SC/VA where SCE is the structural capital efficiency of the firm and SC = VA – HC.

(v). VAIC = CEE + HCE + SCE where VAIC indicates corporate value creation efficiency.

VAIC does not provide the money value of IC. It simply adds the 3 different efficiency factors of IC and calculates an efficiency index that shows how the IC of a firm contributes to value addition. To measure IC efficiency, Pulic (2000) also offers VAIC's subordinate concept that adds human capital and structural efficiency (ICE = HCE + SCE).

(vi) $$\text{Earnings Per Share (EPS)} = \frac{\text{Profit after tax}}{\text{Number of equity shares}}$$

Measures for independent variables identified from the literature review ($X_1$, $X_2$, $X_3$) are efficiency determinants of VAIC, i.e., CEE, HCE, and SCE; the dependent variable (Yi) is earning per share.

$Y_i$ = earnings per share (EPS)
$X_1$ = capital employed efficiency (CEE)
$X_2$ = human capital efficiency (HCE)
$X_3$ = structural capital efficiency (SCE)

This study focused on how to utilize intellectual capital more efficiently, in order to strengthen the competitiveness of public sector enterprises by maximizing earning per share i.e. shareholder's income generation. This research established a novel assessment model to measure the performance of intellectual capital management in two aspects, by using *Grey Relational Analysis(GRA)* to measure operational performance and *Malmquist Productivity Index(MPI)* to judge productivity evaluation.

Gray relational generating means as new information to the system's needs, based on the processed data used to find the rule of data. Hsia's method (Hsia and Wu,1998) is adopted for definition and calculation. Furthermore, the study introduces Deng's grey relation grade (Deng,1989). The complete concepts are described as follows.

### 3.2 Grey Relational Analysis (GRA)

The information that is either incomplete or undetermined is called Grey. The Grey system provides multidisciplinary approaches for analysis and abstract modeling of systems for which the information is limited, incomplete and characterized by random uncertainty.

The 1$^{st}$ order one variable Grey model denoted as GM (1, 1) is especially applicable for forecasting. GM (1, 1) model uses the variation within the system to find out the relations between sequential data and then establish the prediction model.

The three terms that are typical symbols and features for Grey System are:

a) The Grey number in Grey system is a number with incomplete information.
b) The Grey element represents an element with incomplete information.
c) The Grey relation is the relation with incomplete information.

There are several steps of the theory of Grey system :

1. Grey generation: This is data processing to supplement information. It is aimed to process those complicate and tedious data to gain a clear rule, which is called the whitening of a sequence of numbers. The expected goal for each influence factor is determined based on the principle of data processing.
2. Grey modeling: The modeling is performed in order to establish a set of Grey variation equations and Grey differential equations, which is called the whitening of the model. The Grey model is denoted as GM ($n$, $h$), which is a $n$-th order differential equation of $h$ variables. This Grey differential equation is used for infinite information. Most of the previous researchers have focused on GM (1, 1) models because of its computational efficiency. GM (1, 1) model have time – varying coefficients. It means that the model is renewed as the new data become available to the prediction model. A Grey differential equation having $N$ variables is called GM (1, N).
3. Grey prediction: Uses the Grey model to conduct a qualitative prediction, which is called the whitening of development. Grey models predict the future values of a time series based on a set of the most recent data.
4. Grey decision: A decision is made under imperfect countermeasure and unclear situation, which is called the whitening of status. It is primarily concerned with the Grey strategy of situation, Grey group decision making and Grey programming . Grey strategy of situation deals with the strategy making based on multi objects which are contradictory in the ordinary way. It is important to make a satisfactory strategy by means of effect measure maps, which transfer the disconformities samples resulting from different objects into identical scales.
5. Grey relational analysis: Quantifies all influences of various factors and their relation, which is called the whitening of factor relation. It uses information from the Grey system to dynamically compare each factor quantitatively, based on the level of similarity and variability among factors to establish their relation. GRA analyzes the relational grade for discrete sequences.
6. Grey control: Work on the data of system behavior and look for any rules of behavior development to predict future behavior. The predicted value can be fed back into the system in order to enable system control.

This study adopts the above mentioned research steps to develop an influence factors evaluation model based on GRA, and apply to influence factors evaluation and selection. The Grey relational analysis uses information from the Grey system to dynamically compare each factor quantitatively.

Let the number of the listed companies be *m*, and the number of the influence factors be *n*. Then a *m* x *n* value matrix (called eigenvalue matrix) is set up.

$$X = \begin{bmatrix} x_1(1) & x_1(2) & .... & x_1(n) \\ x_2(1) & x_2(2) & ... & x_2(n) \\ \vdots & & & \\ x_m(1) & x_m(2) & ... & x_m(n) \end{bmatrix}$$

where $x_i(k)$ is the value of the number *i* listed company and the number *k* influence factors.
Usually, three kinds of influence factors are included, they are:

1. Benefit – type factor (the bigger the better),
2. Defect – type (the smaller the better)
3. Medium – type, or nominal-the-best (the nearer to a certain standard value the better).

It is difficult to compare between the different kinds of factors because they exert a different influence. Therefore, the standardized transformation of these factors must be done. Three formulas can be used for this purpose.

$$x_i(k) = \frac{x_i(k) - \min x_i(k)}{\max x_i(k) - \min x_i(k)}$$

The first standardized formula is suitable for the benefit – type factor.

$$x_i(k) = \frac{\max x_i(k) - x_i(k)}{\max x_i(k) - \min x_i(k)}$$

The second standardized formula is suitable for defect – type factor.

$$x_i(k) = \frac{\left|x_i(k) - x_0(k)\right|}{\max x_i(k) - x_0(k)}$$

The third standardized formula is suitable for the medium – type factor. Here we have taken the bigger the better.
The grey relation degree can be calculated by steps as follows:

a) The absolute difference of the compared series and the referential series should be obtained by using the following formula:

$$\Delta x_i(k) = \left|x_0(k) - x_i(k)\right|$$

and the maximum and the minimum difference should be found.

b) The distinguishing coefficient *p* is between 0 and 1. Generally, the distinguishing coefficient *p* is set to 0.5.
c) Calculation of the relational coefficient and relational degree as follows.

In Grey relational analysis, Grey relational coefficient $\xi$ can be expressed as follows:

$$\xi_i(k) = \frac{\Delta \min + p\Delta \max}{\Delta x_i(k) + p\Delta \max}$$

and then the relational degree follows as:

$$r_i = \sum \left[ w(k)\xi(k) \right]$$

In equation above, $\xi$ is the Grey relational coefficient, *w (k)* is the proportion of the number *k* influence factor to the total influence indicators. The sum of *w (k)* is 100%. The result obtained when using equation above can be applied to measure the quality of the listed companies.

**3.3 Malmquist Productivity Index (MPI)**

This study uses DEA's malmquist model by using listed Indian Public Sector Enterprises information to analyse efficiency change for all the relevant companies and to measure technical efficiency scores during two particular periods. Secondly, the study analzes technical change and measures the condition of efficiency frontier-shift between two particular periods. Finally, the study analyzes Malmquist productivity index and finds out the main reason of Malmquist productivity change. Moreover, this study also carries out a comparision between the period efficiency and productivity change, in order to understand the situation of every annual growth and decline of efficiency and productivity.

Productivity is generally defined in terms of the efficiency improvement and technical change with which inputs are transformed into outputs in the production process (Coelli et al., 1998). Farrel (1957), mentioned in Forsund and Saarafogulu (2000), defined two types of production efficiency: technical efficiency (TE), which evaluates a firm' ability to obtain the maximum possible output from a given set of inputs, and allocative efficiency (AE) which measures a firm's ability to maximize its profits by comparing marginal revenue product with marginal costs of inputs. However, this econometric approach requires the specifications of production function technology. Recently, mathematical programming approaches, such as Data Envelopment Analysis (DEA) are developed to measure TE by combining the firm's production to the best production frontier.

Specifically, the productivity can be measured by using narrow measures like partial productivity indices or a more comprehensive Total Factor Productivity (TFP). Partial Productivity Indices refer to ratios of output to each of categories of input for which separate data exist. Total factor productivity (TFP) is an overall indicator of how well an organization uses all of its resources to create its products and services. Moreover, TFP is a broader measure of economic and technical efficiency reflecting a diversity of factors including managerial efficiency, economies of scale, R & D, market structure and human capital utilization. TFP can be split up into two major components viz: technological progress and improvement in technical efficiency. It is important at the outset to distinguish between technological progress and improvement in technical efficiency. Technological progress may be attributed to the introduction of new technology, which leads to an expansion of the best production frontier and hence gives higher output even with given input of resource. The other component is improvement in technical efficiency which yields higher output being the result of improved management practices, better industrial relationships, and diffusion of new technological knowledge as well as short run adjustments to shocks, external to the enterprise as technical efficiency change.

Three different indices are frequently used to evaluate technological changes; the Fisher (1922), Tornqvist (1936), and Malmquist (1953) indexes. According to Grifell-Tatje and Lovell (1996), the Malmquist indexes have three main advantages relative to the Fisher, Tornqvist indices. Firstly, it does not require the profit maximization, or cost minimization assumption. Secondly, it does not require information on the input and output prices. Finally, if researcher has panel data, it allows the decomposition of productivity changes into two components (technical efficiency change, and technical change or changes in the best practice).Its main disadvantage is the necessity to compute the distance functions. However, the Data Envelopment Analysis can be used to solve this problem. Following Fare et al. (1994) the Malmquist (output oriented) TFP change index The Malmquist TFP index calculates the change in productivity between two points by estimating the ration of the distances of each point relative to a common technology. The Malmquist input oriented TFP change index between the base period t & the following period t+1 is defined as:

$$M(y_{t,}x_{t,}y_{t+1,}x_{t+1}) = \left[ \frac{d_{t+1}(Y_{t+1,}X_{t+1})}{d_t(Y_{t,},X_t)} X \frac{d_t(Y_{t+1},X_{t+1})}{d_{t+1}(Y_{t+1},X_{t+1})} \right]^{1/2}$$

A value of M greater than unity implies a positive TFP growth from period t to period t+1.Otherwise, a value of M less than one indicates a TFP decline. Equation (7) is geometric mean of two TFP indices. The first index is calculated with respect to period t technology, while the second index is evaluated with respect to period t+1 technology.

The study mainly focuses on using GRA and DEA to probe into intellectual capital management performance of Indian Public Sector Companies. Through literature review, data collection, GRA , DEA we can clearly understand the latest situation of Indian Public Sector's management performance of intellectual capital. Also, this study encourages further transparency and competitiveness promotion of corporate governance and offers the managers the information of traditional accounting financial report that cannot be assessed usually. We emphasize again that intellectual capital is an essential strategy tool that will assist business to strength self-competitive advantage and promote corporate performance.

This study uses companies who are Indian Public Sector Enterprises as DMUs. A total of 50 companies with data from the year 2001-02 to 2010-11 are chosen to be our DMU as empirical sample. There are three inputs, HCE,SCE and CEE and one output EPS. The steps are as follows: when proceeding the part of localization grey relational analysis, the first step must set up referential sequence and comparative sequence. This study factors belong to the small identity, then select the minimum and the large identity, then select the maximum to setup referential sequence. So those 50 companies are comparative sequence. When proceeding, the original data into the grey relational generation, it mainly deals with data processing of the original data that are yet to be true according to actual situation and promotion of data's visualiziability. This study adopts Hsia's method(Hsia and Wu,1998) and proceeds the original data of the HCE,SCE, CEE and EPS(all larger the better).Then calculate the grey relational coefficient and grey relational grade. Followed by the value of the grey relational grade, calculate the grey relational rank ordinal.

## 4 Results

There is now a renewed focus on disinvestments in India. Listed PSUs or Public Sector Undertakings are among the largest and mostly profitable organizations in India. All listed PSUs together constitute 30% of the total market capitalization at BSE or Rs. 19.79 lakh crores. The key objective of this study is to examine the role of HCE,SCE and CEE as an input(all important components of ICE) in creating out firm's EPS (a measurement of shareholder's income or wealth creation).

### 4.1 Grey Relational Analysis (GRA)

As shown in Table-1, the top ranking orders of 50 companies in 10 years are mainly Power Finance Corporation, National Mineral Development Corporation, State Bank of India and so on. The top 3 average grey relation grade ranking order of 50 companies from financial year 2001-02 to 2010-11 are Power Finance Corporation, National Mineral Development Corporation, State Bank of India respectively. Higher grey relational grade means closer to referential sequence.

**Table 1** GRA Rank

| DMUs | Average Grey Relation Grade | Rank |
|---|---|---|
| Power Finance Corporation | 0.4740 | 1 |
| National Mineral Development Corporation | 0.4549 | 2 |
| State Bank of India | 0.4520 | 3 |
| Container Corporation of India Limited | 0.4497 | 4 |
| State Trading Corporation | 0.4477 | 5 |
| Oil India Limited | 0.4455 | 6 |
| Gas Authority of India Limited | 0.4329 | 7 |
| Rural Electrification Corporation | 0.4326 | 8 |
| Bharat Electronics Limited | 0.4315 | 9 |
| Jammu and Kashmir Bank | 0.4303 | 10 |
| Punjab National Bank | 0.4280 | 11 |
| Bharat Heavy Electricals Limited | 0.4277 | 12 |
| Dredging Corporation of India Limited | 0.4274 | 13 |
| Hindustan Petroleum Corporation Limited | 0.4254 | 14 |
| Bharat Petroleum Corporation Limited | 0.4241 | 15 |
| Corporation Bank | 0.4240 | 16 |
| Indian Oil Corporation Limited | 0.4235 | 17 |
| Power Grid Corporation of India Limited | 0.4235 | 18 |
| National Thermal Power Corporation Limited | 0.4232 | 19 |
| Oil and Natural Gas Corporation | 0.4232 | 20 |
| National Aluminium Corporation | 0.4214 | 21 |
| Shipping Corporation of India | 0.4204 | 22 |
| Gujarat Mineral Development Corporation | 0.4201 | 23 |
| Bank of Boroda | 0.4195 | 24 |
| Balmer Lawrie of India | 0.4194 | 25 |
| Canara Bank | 0.4192 | 26 |
| Manganese Ore of India Limited | 0.4174 | 27 |

| DMUs | Average Grey Relation Grade | Rank |
|---|---|---|
| Oriental Bank of Commerce | 0.4172 | 28 |
| Neyveli Lignite Corporation | 0.4144 | 29 |
| Metal and mineral Trading Corporation | 0.4137 | 30 |
| Bharat Earth Movers Limited | 0.4136 | 31 |
| Union Bank | 0.4120 | 32 |
| Industrial Development Bank of India | 0.4118 | 33 |
| Allahabad Bank | 0.4118 | 34 |
| Bank of India | 0.4116 | 35 |
| National Fertilisers Limited | 0.4110 | 36 |
| Andhra Bank | 0.4100 | 37 |
| Engineers India Limited | 0.4098 | 38 |
| Coal India Limited | 0.4094 | 39 |
| Rashtriya Chemical and Fertilisers Limited | 0.4089 | 40 |
| Indian Bank | 0.4089 | 41 |
| Steel Authority of India Limited | 0.4089 | 42 |
| Indian Overseas Bank | 0.4083 | 43 |
| Syndicate Bank | 0.4079 | 44 |
| Vijaya Bank | 0.4059 | 45 |
| Dena Bank | 0.4046 | 46 |
| Hindustan Copper | 0.4046 | 47 |
| Bank of Maharashtra | 0.4043 | 48 |
| UCO Bank | 0.4034 | 49 |
| Mahanagar Telecom Nigam Limited | 0.3987 | 50 |

### 4.2 Malmquist Productivity Index (MPI)

This analysis will explore the relationship between the intellectual capital management and earning per share, evaluating the efficiency and productivity of the intellectual capital. Researcher has selected 3 inputs HCE,SCE and CEE and 1 output EPS suitably to correlate to the components of the intellectual and to performance, with the aim to analyse productivity and efficiency of Intellectual capital and the relationship between intellectual capital management and business performance, earning per share. Researcher has used EMS (Efficiency Measurement System) ver 1.3 developed by Holger Scheel.

**Table 2** MPI Rank

| Sl. No. | DMU | Score | HCE {I}{V} | SCE {I}{V} | CEE {I}{V} | EPS {O}{V} | Benchmarks | {S} HCE {I} | {S} SCE {I} | {S} CEE {I} | {S} EPS {O} |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | {X} RCFL (2001-02) | 4714.68% | 0 | 5.73 | 76.9 | 1 | 451 (0.14) 452 (0.19) 489 (0.67) | 0.8 | 0 | 0 | 0 |
| 2 | {X} RCFL (2002-03) | 0.00% | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 |
| 3 | {X} RCFL (2003-04) | 1041.95% | 0 | 0.91 | 14.7 | 1 | 451 (0.06) 452 (0.09) 489 (0.85) | 0.74 | 0 | 0 | 0 |
| 4 | {X} RCFL (2004-05) | 1539.47% | 0 | 0 | 17.8 | 1 | 452 (0.02) 489 (0.98) | 0.8 | 0.02 | 0 | 0 |
| 5 | {X} RCFL (2005-06) | 1261.42% | 0 | 1.07 | 17.4 | 1 | 451 (0.04) 452 (0.08) 489 (0.89) | 0.9 | 0 | 0 | 0 |
| 6 | {X} RCFL (2006-07) | 1020.01% | 0 | 1.09 | 14.9 | 1 | 451 (0.07) 452 (0.14) 489 (0.79) | 1.34 | 0 | 0 | 0 |
| 7 | {X} RCFL (2007-08) | 1123.26% | 0 | 0.97 | 15.7 | 1 | 451 (0.05) 452 (0.09) 489 (0.86) | 0.75 | 0 | 0 | 0 |

| Sl. No. | DMU | Score | HCE {I}{V} | SCE {I}{V} | CEE {I}{V} | EPS {O}{V} | Benchmarks | {S} HCE {I} | {S} SCE {I} | {S} CEE {I} | {S} EPS {O} |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | {X} RCFL (2008-09) | 983.13% | 3.45 | 0.51 | 10.1 | 1 | 451 (0.03) 452 (0.03) 489 (0.89) 490 (0.06) | 0 | 0 | 0 | 0 |
| 9 | {X} RCFL (2009-10) | 732.63% | 0 | 0.56 | 10.4 | 1 | 451 (0.08) 452 (0.08) 489 (0.84) | 0.14 | 0 | 0 | 0 |
| 10 | {X} RCFL (2010-11) | 918.34% | 0.96 | 0 | 0 | 1 | 489 (0.78) 490 (0.22) | 0 | 0.01 | 0.04 | 0 |
| 11 | {X} REC(2001-02) | 585.19% | 0 | 0 | 0 | 1 | 489 (1.00) | 12.49 | 0.31 | 0.07 | 0 |
| 12 | {X} REC(2002-03) | 554.39% | 0 | 0 | 0 | 1 | 489 (1.00) | 18.88 | 0.33 | 0.17 | 0 |
| 13 | {X} REC(2003-04) | 526.67% | 0 | 0 | 0 | 1 | 489 (1.00) | 18.72 | 0.33 | 0.12 | 0 |
| 14 | {X} REC(2004-05) | 410.39% | 0 | 0 | 0 | 1 | 489 (1.00) | 25.38 | 0.34 | 0.12 | 0 |
| 15 | {X} REC(2005-06) | 502.82% | 0 | 0 | 0 | 1 | 489 (1.00) | 15.06 | 0.32 | 0 | 0 |
| 16 | {X} REC(2006-07) | 465.37% | 0 | 0 | 5.38 | 1 | 452 (0.03) 489 (0.97) | 15.79 | 0.26 | 0 | 0 |
| 17 | {X} REC(2007-08) | 441.72% | 0 | 0 | 0 | 1 | 489 (1.00) | 10.64 | 0.3 | 0.02 | 0 |
| 18 | {X} REC(2008-09) | 277.38% | 0 | 0 | 0 | 1 | 489 (1.00) | 18.65 | 0.33 | 0.05 | 0 |
| 19 | {X} REC(2009-10) | 178.14% | 0 | 0 | 0 | 1 | 489 (1.00) | 20.54 | 0.33 | 0.07 | 0 |
| 20 | {X} REC(2010-11) | 151.33% | 0 | 0 | 1.75 | 1 | 452 (0.02) 489 (0.98) | 24.55 | 0.28 | 0 | 0 |
| 21 | {X} SAIL(2001-02) | 0.00% | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 |
| 22 | {X} SAIL(2002-03) | 0.00% | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 |
| 23 | {X} SAIL(2003-04) | 654.85% | 0.54 | 0 | 0 | 1 | 489 (0.08) 490 (0.92) | 0 | 0 | 0.14 | 0 |
| 24 | {X} SAIL(2004-05) | 248.97% | 0 | 0 | 0 | 1 | 489 (1.00) | 0.63 | 0.07 | 0.41 | 0 |
| 25 | {X} SAIL(2005-06) | 418.27% | 0.43 | 0 | 0 | 1 | 489 (0.69) 490 (0.31) | 0 | 0.01 | 0.19 | 0 |
| 26 | {X} SAIL(2006-07) | 273.50% | 0 | 0 | 0 | 1 | 489 (1.00) | 0.31 | 0.04 | 0.29 | 0 |
| 27 | {X} SAIL(2007-08) | 225.10% | 0 | 0 | 0 | 1 | 489 (1.00) | 0.2 | 0.03 | 0.34 | 0 |
| 28 | {X} SAIL(2008-09) | 272.02% | 0.28 | 0 | 0 | 1 | 489 (0.68) 490 (0.32) | 0 | 0.01 | 0.25 | 0 |
| 29 | {X} SAIL(2009-10) | 251.25% | 0 | 0 | 0 | 1 | 489 (1.00) | 0.34 | 0.04 | 0.13 | 0 |
| 30 | {X} SAIL(2010-11) | 340.99% | 0.33 | 0 | 0 | 1 | 489 (0.56) 490 (0.44) | 0 | 0.01 | 0.09 | 0 |
| 31 | {X} SBI(2001-02) | 51.86% | 0.78 | 0.01 | 0 | 1 | 0 | | | | |
| 32 | {X} SBI(2002-03) | 44.47% | 0.65 | 0.01 | 0 | 1 | 0 | | | | |
| 33 | {X} SBI(2003-04) | 37.47% | 0.53 | 0.01 | 0 | 1 | 0 | | | | |
| 34 | {X} SBI(2004-05) | 35.82% | 0.52 | 0.01 | 0 | 1 | 0 | | | | |
| 35 | {X} SBI(2005-06) | 31.25% | 0.47 | 0.01 | 0 | 1 | 0 | | | | |
| 36 | {X} SBI(2006-07) | 29.27% | 0.43 | 0.01 | 0 | 1 | 0 | | | | |
| 37 | {X} SBI(2007-08) | 17.86% | 0.06 | 0.01 | 0.2 | 1 | 0 | | | | |
| 38 | {X} SBI(2008-09) | 23.07% | 0.02 | 0 | 0 | 1 | 0 | | | | |
| 39 | {X} SBI(2009-10) | 20.28% | 0.05 | 0.01 | 0.23 | 1 | 0 | | | | |
| 40 | {X} SBI(2010-11) | 19.47% | 0.29 | 0 | 0 | 1 | 0 | | | | |
| 41 | {X} SCI(2001-02) | 479.91% | 0 | 0 | 0 | 1 | 489 (1.00) | 1.89 | 0.16 | 0.06 | 0 |
| 42 | {X} SCI(2002-03) | 372.13% | 0 | 0.31 | 5.02 | 1 | 451 (0.01) 452 (0.06) 489 (0.93) | 1.14 | 0 | 0 | 0 |
| 43 | {X} SCI(2003-04) | 184.96% | 0 | 0 | 0 | 1 | 489 (1.00) | 3.06 | 0.2 | 0.06 | 0 |
| 44 | {X} SCI(2004-05) | 81.67% | 0 | 0 | 0 | 1 | 0 | | | | |
| 45 | {X} SCI(2005-06) | 111.27% | 0 | 0 | 0 | 1 | 489 (1.00) | 3.55 | 0.22 | 0.01 | 0 |
| 46 | {X} SCI(2006-07) | 85.75% | 0 | 0.1 | 1.2 | 1 | 0 | | | | |

| Sl. No. | DMU | Score | HCE {I}{V} | SCE {I}{V} | CEE {I}{V} | EPS {O}{V} | Benchmarks | {S} HCE {I} | {S} SCE {I} | {S} CEE {I} | {S} EPS {O} |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | {X} SCI(2007-08) | 95.76% | 0 | 0.12 | 1.38 | 1 | 0 | | | | |
| 48 | {X} SCI(2008-09) | 120.17% | 0 | 0.15 | 1.76 | 1 | 451 (0.07) 452 (0.16) 489 (0.78) | 2.46 | 0 | 0 | 0 |
| 49 | {X} SCI(2009-10) | 160.17% | 0 | 0.32 | 3.03 | 1 | 451 (0.17) 452 (0.26) 489 (0.57) | 1.8 | 0 | 0 | 0 |
| 50 | {X} STC(2010-11) | 92.94% | 0 | 0.24 | 1.89 | 1 | 0 | | | | |

In the Table 2 the researcher has observed that under variable return to scale and output oriented DEA model SBI is most efficient (all score are < 100%). More so, in the year 2007-08 when the score is 17.86% (most least score). This is the benchmark result.

## 5 Conclusions

As a pioneering attempt to analyze the performance of BSE-PSU from the perspective of IC, this paper is a good source of reference for future research in the Indian corporate sector. The study is based on strong theoretical foundations and research-proven methodology. The data utilized in this study are also prepared by qualified accountants and audited by statutory auditors, thus increasing reliability. Additionally, this study contributes to the existing literature in the following ways:

1. It provides the evidence on the role of HCE, SCE and CEE in shareholders earnings of a company using last ten-year data for different industrial sectors of the BSE.
2. More than 30% of investors at the BSE and fund and portfolio managers will benefit from the idea of IC modeling as a better measure of evaluating the firm than the traditional approach of net profitability while developing a portfolio. They can observe the impact of IC efficiency not only on annual dividends but also on capital gains.

The study proves that VAIC can be used by regulatory authorities to identify the weaknesses and strengths of different PSUs.

The study is conducted to examine the relationship between IC and a firm's EPS through empirical research, which has been concluded successfully. The contribution of this research is important both for academic researchers as well as business professionals. IC literature is beneficial in deciding the potential role of ICE in a firm's performance, more so on shareholders value: business professionals benefit by understanding the importance of allocating their precious resources to support IC and ultimately the firm's shareholders earning. Keeping in view the significant role of IC in shareholder earning, the study emphasizes the need for guidelines for measuring and disclosing IC in financial reports. As a supervisory body for the corporate sector, the Securities and Exchange Board of India (SEBI) and the Institute of Chartered Accountants of India and the Institute of Cost and Works Accountants of India, are urged to take the initiative in this regard. Moreover, as India opens its stock markets to more and more foreign investors who need financial and nonfinancial information to assist in their decision making, reporting IC becomes all the more important. In a global environment, if information related to IC, health, safety, environment, and corporate social responsibility issues are disclosed in firms' annual reports, it could enhance their value in the eyes of international investors. This study is one of the first empirical tests of association between IC and a firm's shareholders' earning in India, thus providing a good source for IC researchers in the future.

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