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Research Article

Analyzing Efficiency of Indian Life Insurance Companies using DEA and SEM

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Abstract: Insurance companies play a significant role in the economic growth of an economy. This paper explores the performance of the life insurance companies working in India during the period 2010 to 2017. Each of the selected insurance companies has been recognized as a separate Decision Making Unit (DMU) and their performance has been analyzed with respect to their peers in the industry. Data Envelopment Analysis (DEA) is carried out to estimate the efficiency of these insurance companies using a set of inputs and outputs. An input oriented model has been used to identify the DMU that is able to minimize input while maintaining the same or more output. The efficiency scores measure the efficiency of the DMUs in minimizing the costs. In input oriented DEA, it becomes important to differentiate between multiple efficient DMUs with an efficiency score of 1. Hence super efficiency score has been used to rank the DMUs. The model has been validated through Structural Equation Modeling (SEM) before performance measurement using DEA. In this paper, comparative analysis has been carried out with other Multi Criteria Decision Making techniques(MCDM) such as Simple Additive Weighting (SAW), Weighted Aggregated Sum Product Assessment (WASPAS),Weighted Sum Method (WSM), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS),Range of value method (ROVM), The Additive Ratio Assessment (ARAS), Measurement Alternatives and Ranking according to the COmpromise Solution (MARCOS) to show the correlation between different methods and to uphold the reliability of the proposed methodology.

Keywords: Insurance efficiency; Technical efficiency; DEA; SEM; Value-added approach.

1. Introduction

Insurance companies as financial institutions have two fold contribution for the growth and efficient functioning of the economy. They not only facilitate businesses by mitigating the risk but also act as financial intermediaries by bringing savers and borrowers together. Insurance companies are also one of the major institutional investors. Therefore, we cannot undermine the importance of the insurance companies for businesses, individuals and the overall economy.

In India major studies have analyzed the financial performance of the insurance companies using ratio analysis. In India there is a lack of studies analyzing the performance of insurance companies using the different MCDM that have evolved over the decades. These models are being extensively used to study the performance of insurance companies across the world. In the life insurance business in India, LIC has been the market leader for decades. With the liberalization of the sector many private insurance companies are trying to make a dent in the market share and are emerging as major competitors. Hence, in analyzing performance of a company, it is necessary to estimate their performance relative to their peers. In this context the present study attempts to examine the efficiency of the Indian Life Insurance companies by using the Data Envelopment Analysis (DEA) and Structural Equation Modeling (SEM). Unlike Ratio analysis where financial ratios such as the return on equity, return on assets, expense to premium ratios, etc are used, Data Envelopment Analysis measures firm performance relative to "best

practice" frontiers consisting of other firms in the industry. This research applied Data Envelopment Analysis (DEA) to estimate the efficiency of major Indian Life Insurance Companies and to rank them as per performance. The model has been validated through Structural Equation Modeling (SEM).

DEA is a linear programming technique for building an efficient frontier. It is considered as a non-parametric approach because it is constructed through the envelopment of the Decision Making Units (DMUs) and it places the best performing DMUs on the efficient frontier. It has many benefits such as; it allows '0' as an output vector and most of the researchers use DEA in case of small sample size.

This study has followed the value added approach to determine the output variables. According to value added approach, insurers provide three key services; risk pooling & risk bearing, financial services relating to insured losses and financial intermediation services. The value added approach judges all categories of financial parameters to have some output characteristics in case of differentiating inputs from outputs in a mutually exclusive way. If a financial product contributes considerably based on its operational cost allocation method then it will be taken into account as output variable Berger et al., **[1]**.

2. Review of Literature

Numerous studies have examined the efficiency and the issues related to Insurance companies. Some studies have also focused the effect of risk management on the efficiency of insurers Cummins et al., **[2]**; Cummins & Nini **[3]**. Many researchers investigated the level of efficiency in insurance markets in different nations, be it emergent or emerging, it was found that the output is mixed. Weiss [30] measured the efficiency of 100 US property and liability insurance companies from the period 1980 to 1984 by the application of Stochastic Frontier Approach (SFA). Moreover, Cummins **[4]** applied DEA to calculate the efficiency of 750 life insurers of U.S. in the duration 1988 to 1995 and found that the insurance firms have lower efficiency rates as compared to the other financial sectors. Cummins, Turchetti and Weiss **[5]** used DEA techniques to calculate the technical efficiency of 94 life and non-life insurers in Italy from the period of 1985-1993. Another study by Hussels and Ward **[6]** used DEA and DFA to calculate the efficiency level of German and U.K. life insurers over the period 1991-2002. The comparative study found that the insurers of U.K insurance market were less efficient than the German insurers. Tone and Sahoo **[7]** used variant DEA to estimate the cost efficiency and return to scale in the Indian life insurance companies over the period 1982-2001. Qiu & Chen **[8]** measured the efficiency of 32 life insurers of China over the period 2000 to 2003 and reported a decline in the efficiency of insurance companies. Mansoor and Radam **[9]** used DEA to examine the general level of technical efficiency and productivity for 12 Malaysian life insurers over the period 1987-1997. Kasman and Turgutlu **[10]** applied deterministic DEA, chance- constrained DEA (CCDEA) and SFA to investigate the technical efficiency of some Turkish life insurance firms for the period 1995-2005.

While checking the insights of recent literature, Dutta and Sengupta **[11]** applied DEA to calculate the scale efficiencies using a panel dataset of 14 life insurance companies during the year 2004-09. Wu and Zeng **[12]** used computer technology LINDO software and SAS systems to evaluate the super efficiency, technical efficiency, pure technical efficiency and scale efficiency of life insurance of China by using DEA approach. Huang and Eling **[13]** estimated the efficiency of non-life insurance companies in four fastest emerging markets – Brazil, Russia, India, China (The BRIC) using multi stage DEA. Moreover, this paper analyzed the incorporation of uncontrolled variables and it was noticed that the political and economic environment affects the efficiency of the non-life insurance in BRIC countries. Nandi **[14]** applied a linear programming, DEA to measure the technical efficiency of top 13 life insurance companies of India which includes 12 private sectors and 1 public sector companies. The study focuses on maximizing output, thus output oriented DEA was used. Ram Pratap Sinha **[15]** used a dynamic slack based DEA model for the evaluation of 15 life insurance companies during the year (2005-2006 to 2011-12). Grmanova and Struntz **[16]** applied DEA model to express the technical efficiency scores. In addition to it, Tobit regression model and the Mann-Whitney U-Test were used to determine the relationship between technical efficiency and profitability of insurance companies. Nourani **[17]** employs dynamic network DEA to measure the technical efficiency of the Malaysian Insurance companies over the period

2007-2014. Kaffash and Marra **[18]** investigated the DEA method and diffused the method in three financial services- banking groups, market funds and insurance groups. Saha and Roy **[19]** applied DEA to examine the comparison of the efficiency of 24 life insurance companies in India over the period 2015-16. This paper used three input- three output frameworks to estimate the technical efficiency score using Charnes Cooper Rhodes (CCR) **[20]** envelopment model. Jaloudi **[21]** used DEA models to evaluate the technical efficiency scores, slack based Logit model to examine the efficiency determinants in the Jordan Insurance market. Ram Pratap Sinha **[22]** used network DEA models for estimating the performance of non- life insurance companies. Ghosh and Dey **[23]** used DEA and Super efficiency model to find the efficiency of General Insurance Companies of India during 2011 to 2017. Dey and Ghosh **[24]** applied DEA to measure efficiency of General Insurance Companies, segregating them into private and public sector in India using DEA. Bulgurcu. B **[25]** proposed a multi criteria decision making model to measure and compare the financial performance of thirteen technology firms listed in Istanbul Stocks exchange .The study employs ten financial of thirteen firms for the period between 2009 to 2011 to examine the financial performance scores of these firms by using TOPSIS technique. Sami.M and Munat **[26]** aimed to determine the priorities of the criteria to select the optimum independent auditing company. The study employed AHP and TOPSIS method to select the best audit company. Sari.T and Kayral.I.E **[27]** in their research study investigated the key criteria in analysing bank performance and efficiency in terms of relative performance of ten Turkish commercial banks with highest market share for eleven years from 2008 to 2018 on the basis of 17 financial ratios. The study applied TOPSIS methodology combined with step-wise regression analysis. Yakowitz, D. S., Lane, L. J., & Szidarovszky, F. **[28]** examined ROVM tool to assist a decision maker with the task of ranking a finite number of alternatives based on a finite number of attributes.

2.1 Motivation of the proposed study:

This study contributes to the existing literature of Efficiency Measurement of Life Insurance companies of India who together accounts for 92% of the market share. This research applied Data Envelopment Analysis (DEA) Super Efficiency model to estimate the efficiency through the value-added approach and the model has been validated through Structural Equation Modeling (SEM). A comparative analysis has been carried out and the correlation analysis among different methods creates insight. The peer report of DEA helps in understanding the peers in the Indian Insurance sphere.

2.2 Novelty of the present study:

(a) In this research Value Added Approach has been applied to find out the efficiency of life insurance companies of India who together accounts for more than 90% of the market share for the period under study.

(b) The model has been validated through structural equation modelling (SEM)**.**

(c) Comparison analysis has been conducted to obtain fluctuation in ranking by the application of different MCDM techniques. The results obtained in this study depicts DEA model being a linear programming optimization model stands out from other MCDM techniques.

2.3 Benefits of DEA over other methodologies

An analytical criteria methods are decision making methods which prioritize the items by comparing each other with the weighting factors of the alternatives and provides the best to worst or worst to best alternatives from the choices. The data envelopment analysis is an analytical criteria method which is a mathematical programming based optimization technique. It gives the performance based evaluation from the criteria of order to choose the alternatives. A Multi Criteria Decision Making (MCDM) method uses a common set of weights that express a decision maker's preferences, in contrast, the DEA does not provide a common set of weights that could express the preferences of a decision maker. A comparison of DEA and MCDM shows that DEA resembles MCDM, but the results differ. In spite of these differences, DEA could be used as a supplement for screening alternatives within MCDM. (Opricovic, S., & Tzeng, G. H.

(2003)) **[29]** Instead of distance based MCDM techniques where distance from positive ideal solution and negative ideal solutions are calculated for ranking, DEA is used for multiple input and multiple output with their weights values obtained from linear optimization technique which leads to efficiency measurement and subsequent ranking. The main focal point of the DEA model is to compare alternatives in terms of their efficiency in converting inputs into outputs either by consuming less input or by producing more output. **[30-39]**

The rest of the paper is organized in the following way: **section 3** discusses the methodology and design of the problem, data collection is included in **section 4**. Data analysis and its interpretation are covered in **section 5**. Comparative analysis is represented in **section 6**. Finally conclusion, limitation and future scope is depicted in **section 7** and **8** respectively.

3. Methodology

Data Envelopment Analysis (DEA) has been applied for the computation of efficiency scores regarding the insurance companies of India. It is a non- parametric approach as it is constructed through the envelopment of the Decision Making Units (DMUs). All efficiencies are estimated on the basis of Variable Return to Scale (VRS) instead of Constant Return to Scale (CRS) because there is significant difference between the sizes of the insurers in India. An input oriented DEA model was run to compute the efficiency scores. The estimation of technical efficiency of each DMU from DEA approach is estimated by following Banker et al. **[40]**. This study used the value added approach to determine the productivity variables.

The input-oriented VRS technique requires the solution of the following LP problem due to Banker, Charnes, Cooper **[40]**:

Min θ

Subject to

$$\sum_{j=1}^{a} w_j x_i^j \leq \theta x_i^t; i = 1, 2, 3, \dots, b$$

$$\sum_{j=1}^{a} w_j y_r^j \geq y_r^t;\ r = 1, 2, 3, \dots, l$$

$$\sum_{j=1}^{a} w_j = 1;$$

$$w_j \geq 0 (j = 1,2,3, \dots, a);$$

Where w_j is the weight of the j^{th} DMU, x_i^j is value of the i^{th} input variables for j^{th} DMU, y_r^j is value of the r^{th} output variables for j^{th} DMU and x_i^t is the value of i^{th} input variable for t^{th} DMU. Number of inputs is 'b', number of outputs is 'l' and the number of DMUs is 'a'. Here the value of θ signifies the efficiency of the DMU.

Super Efficiency Model, Anderson & Peterson [41]:

$$\delta = min[\theta - \varepsilon(d_1^T s^- + d_2^T s^+)]$$

$$\text{s.t} \sum_{l=1, d \neq k}^{m} \lambda_l x_l + s^- = \theta x_k ;$$

$$\sum_{l=1, d \neq k}^{m} \lambda_l y_l - s^+ = y_k ; \quad \lambda, s^+, s^- \geq 0$$

Where x_k is an b-dimensional input vector and y_k is a l-dimensional output vector for the k^{th} unit, θ is a scalar which defines the share of the kth DMUs input vector which is required in order to produce the kth DMUs output vector within the reference technology. λ is an intensity vector in which λ_l signifies the

intensity of the l[th] unit, ε is a non-Archimedian infinitesimal. Here, d_1^T and d_2^T are the row vector (1, ….,1) of appropriate dimension.

In 1918, Sewall Wright **[42]** published the first application of path analysis, which modeled the bone size of rabbits. During 1970 this technique has become popular and numerous papers were published. Since the early 1980's, path analysis has evolved into a variety of causal or structural equations modeling (SEM) programs and computer packages. SEM is a general term encircling a variety of statistical models and is used to estimate the path relationship among the constructs. It is used to test the complex relationship among the constructs proposed in the theoretical model. Pearl **[43]** argues that SEM allows us to test out theories with non-experimental data under the assumption that a causal model is true. To assess the model fit for SEM, various types of fit indices are used.

Apart from DEA super Efficiency model, Range of Value Method (ROVM) developed by Yakowitz, D. S., Lane, L. J., & Szidarovszky, F. **[28]** to rank the alternatives from a set of criteria has been applied. Additive Ratio Assessment (ARAS) developed by Zavadskas, E. K., & Turskis, Z **[44]** referred to a real case study where the evaluation of microclimate in office rooms were taken to improve the environment in office premises. Stević, Ž., Pamučar, D., Puška, A., & Chatterjee, P. **[45]** applied MCDM technique Measurement of Alternatives and Ranking according to Compromise Solution (MARCOS) for supplier selection in the healthcare industry. Simple Additive Weighting (SAW) developed by Harsanyi, J. C. **[46]** is an easy and simple process, used for multiple attribute decision making (MADM). Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) developed by Hwang, C. L., & Yoon, K. **[47]** is based on distance measure of the alternatives from positive ideal solution (PIS) and negative ideal solution (NIS). Weighted Sum Model (WSM) developed by Zadeh LA **[48]** is basic and simple methodology in multiple criteria decision making (MCDM). Weighted Aggregated Sum-Product Assessment (WASPAS) developed by Zavadskas, E. K., Turskis, Z., Antucheviciene, J., & Zakarevicius, A. **[49]** is a combination of WSM and weighted product model (WPM). These MCDM methods **[28, 44-54]** have been applied to show the correlation between ranks obtained through them.

3.1. Design of the proposed model

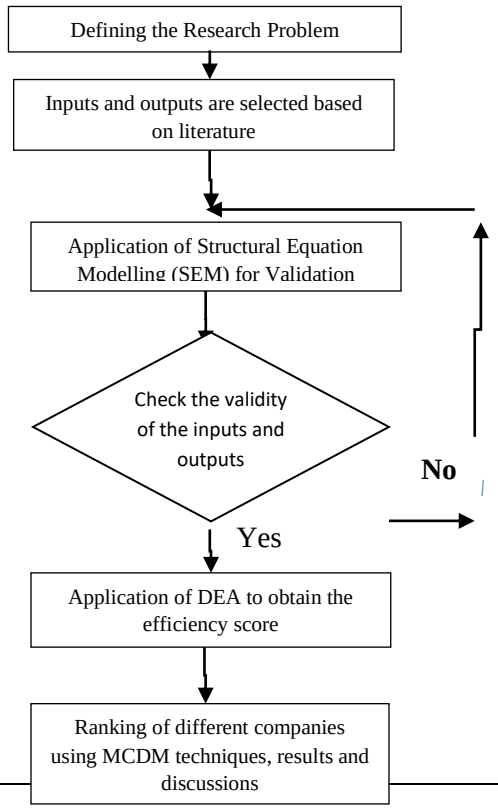

Figure 1: Flow chart for the proposed study

4. Data Collection

The insurance industry of India consists of 52 insurance companies of which 24 are in life insurance biness and 28 are non-life insurers. Among the life insurers, Life Insurance Corporation (LIC) is the sole public sector company. The present study concentrates on life insurance companies in India. The top players SBI Life, ICICI Prudential, Reliance Nippon Life(RNL), Birla Sun Life(BSL), LIC, Tata AIA, Ing Vysya, Bajaj Allianz, Max Life, HDFC Life and Kotak Life Insurance have been included in the study as they together account for 92% of the market share. The present study has been done over the period 2010-11 to 2016-17 i.e., a period of 7 years. The data has been collected from the annual report of all the companies for the 7 years. Max Life got merged with HDFC Life, hence from the year 2015-16 onwards it has not been taken into consideration as a separate entity.

Table 1: The input and output data for the study

Input [55]	**Output [55]**
Commission to Premium ratio	Premiums
Operating Expense	
Fixed Asset	Investment incomes
Equity to total asset ratio	

The present study adopts Houston & Simon **[56]** who argued that premiums paid should be used as a proxy for output which is analogous to measuring output as total sales. The insurance companies provide protection to the insured in the event of accidents and mishaps against the premium paid.

Apart from mitigating various risks, insurance firms act as financial intermediaries by investing the funds which they receive as premium from policyholders. Researchers have used invested assets or investment income as a financial variable to represent the intermediary function of the insurers. Present study has considered the investment incomes as the second output variable. Each of the insurance companies tries to increase their business by increasing their income which takes the form of premiums earned and returns received on invested funds.

In India, the common people are not internet savvy and they are skeptical about online transactions. Under the circumstances, the insurance companies following the model of LIC thereby depending on a wide network of agents. Hence, the commission paid to the agents is a major cost to the companies. As higher business also means higher commission, we have included commission to premium ratio as an input. The insurance companies operate through various branches across different cities as the digital platform is not popular among the common people. Hence it involves a substantial amount of operation cost. This also includes the huge paperwork that is involved with each policy. Operation cost is our second input. The third input is the fixed assets that are required in an office set up as each branch has to maintain certain floor layout and ambience for the hundreds of footfalls. This expense could have been averted if we could transform to a digital platform. The fourth input in our study is the equity to total asset ratio. Each of the insurance companies will have to maintain a certain level of equity capital to establish their trustworthiness among the insured. The equity capital assures the investors that the insurance companies have the ability to meet their claims payable in the event of mishaps and accidents. In our study we have used covariance based SEM (CB-SEM) to confirm or reject the relationship between multiple variables.

5. Data Analysis and Interpretation

The following analysis has been performed for all the years taken under study.

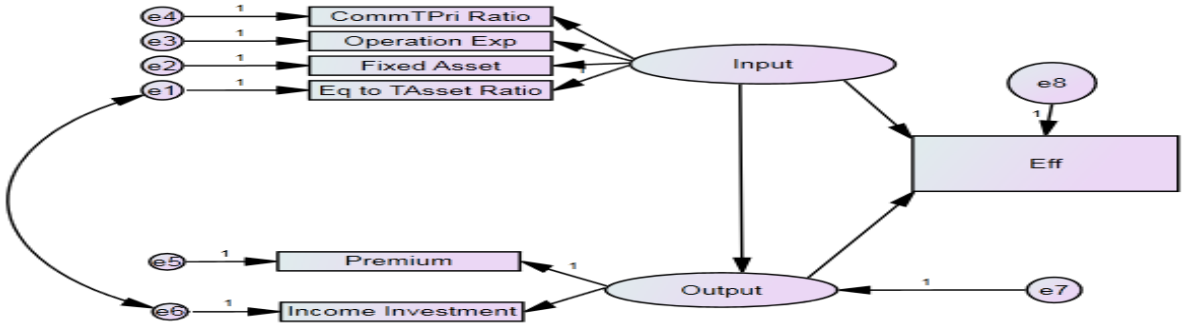

Figure 2: Representation of the path diagram of the model

In this study we focus on four inputs and two outputs. The logic is that the insurance companies employ these four inputs to generate the outputs. Since, an input oriented model has been used and the focus is to identify the DMU that is able to minimize cost while maintaining the same or more output. Hence, the top performers will be the ones that will be able to put a lid on the costs. The efficiency scores measure the efficiency of the DMUs in minimizing the cost.

Table 2: Description of the path significance of all the years.

Fit Indices	**Recommended values**	**Model Values**						
		10-11	11-12	12-13	13-14	14-15	15-16	16-17
X^2	NA	17.187	17.89	16.78	18.26	20.76	17.2	19.03
Df	NA	11	11	10	10	12	11	11
P	>0.05	0.10	0.08	0.79	0.51	0.054	0.10	0.06
GFI	>0.80	0.81	0.83	0.83	0.825	0.82	0.83	0.849
NFI	>0.90	0.91	0.908	0.916	0.919	0.91	0.91	0.91
CFI	>0.90	0.964	0.96	0.962	0.96	0.951	0.96	0.95
Hoelter 5%	More than sample size	12	12	11	11	11	11	10
Hoelter 1%	More than sample size	15	14	14	13	13	13	12
RMSEA	Less than 0.08	0.101	0.105	0.103	0.12	0.102	0.101	0.1

From the above table it is clearly evident that the goodness of fit statistics is within the tolerance limit ($p > 0.05$) and statistically insignificant, i.e. the proposed model fits the data. Goodness of Fit Index (GFI) values are above the recommended value, it indicates that the proposed model is the best fit. Normed fit index (NFI) and Comparative fit index (CFI) in baseline comparisons greater than the recommended value of 0.9. Hoelter at 5% and 1% values are greater than the number of DMU's. This suggests that the efficiency values are being validated.

In input oriented DEA VRS, there is often more than one DMU with an efficiency score of 1. It becomes important to differentiate between multiple efficient DMUs. Hence super efficiency score has been used to rank the DMUs as the DMU with higher super efficiency score is the better performer.

Table 3: Input data, efficiency score and ranking for the year 2010-11

2010-11	**CPP {I}**	**OEX {I}**	**FA {I}**	**EPTA {I}**	**PE {O}**	**IFI {O}**	**Efficiency score**	**Rank**
SBI LIFE	0.0520	9166301	2831553	0.0253	129091662	13284460	1.659	5
ICICI	0.0315	21873948	1985430	0.0204	178169762	19021397	1.610	6

PRU								
RNL	0.0786	15627014	81340	0.0567	65478552	4011926	6.436	1
BSL	0.0680	12034778	399823	0.0919	55945624	7715638	0.943	8
LIC	0.0654	169802811	28394052	0.0000	2033580475	776666851	1	7
TATA AIA	0.0620	9387685	511499	0.1381	39728662	4247266	0.829	9
ING VYSYA	0.0766	4944121	96425	0.2083	17052874	2261838	2.351	3
BAJAJ ALLIANZ	0.0644	16065847	1653709	0.0038	95751789	9378252	4.281	2
MAX LIFE	0.0941	14404401	1402014	0.1271	57362068	4505131	0.569	11
HDFC	0.0532	14952066	2395729	0.0705	89547169	9204070	0.768	10
KOTAK	0.0443	5800575	438489	0.0585	29409630	3693283	1.753	4

For the year 2010-11 considering the input output combination mentioned above, Reliance Nippon Life ranked one, followed by Bajaj Allianz and ING Vysya in that order. The poor performers were MAX life, HDFC Life and TATA AIA.

India has immense potential for growth when it comes to life insurance with a penetration at less than 4.5% of the GDP. A significant portion of this opportunity comes from India's favorable population demographic residing in semi-urban and rural markets. These small and primeval towns have metamorphosed into centers of potential through better access to technology, education, improved infrastructure and self-reliance. The surge of commercialization and digitization has also touched their lives leading to improved standard of living. There is growing awareness of the need for protection and retirement as well as recognition of insurance as an investment avenue. The focus of Reliance Nippon Life has been on these upcoming towns and villages with over 50% of its branches in semi-urban and rural areas. They source around 25% of their policies from the rural areas. [Reliance Nippon Life Annual Report, 2016-17]

Table 4: Input data, efficiency score and ranking for the year 2011-12

2011-12	**CPP {I}**	**OEX {I}**	**FA {I}**	**EPTA {I}**	**PE {O}**	**IFI {O}**	**Eff**	**Rank**
SBI LIFE	0.0396	10239285	2652156	0.0213	130808410	21214478	1.460	5
ICICI PRU	0.0435	20034728	1804306	0.0199	139278800	22363985	1.316	6
RNL	0.0728	12812500	69603	0.0566	54702453	4357820	5.393	1
BSL	0.0566	12151175	395861	0.0879	57477737	9567643	0.962	9
LIC	0.0692	149144012	28639090	0.0001	2028029033	902668686	1	8
TATA AIA	0.0390	7601911	273858	0.1241	36182479	5606239	1.197	7
ING VYSYA	0.0792	4814783	95150	0.1963	16730360	2813708	2.014	3
BAJAJ ALLIANZ	0.0519	14062756	2262424	0.0038	74837954	11065710	3.865	2
MAX LIFE	0.0941	12400539	1199399	0.1123	63208404	6222973	0.669	11
HDFC	0.0569	12698847	2795451	0.0593	101498675	12605318	0.705	10
KOTAK	0.0388	5546026	365655	0.0530	28929202	4696449	1.69	4

For the year 2011-12 considering the input output combination mentioned above, the top performers were Reliance Nippon Life, Bajaj Allianz and ING Vysya. The inefficient were MAX life, HDFC Life and Birla Sun Life.

The issue of under penetration in life insurance arises from problems of servicing the remote areas rather than a shortage of demand. Reliance Nippon Life has been quick to identify this and address the issue. They have the largest network of branches among the private players. For Reliance Nippon Life, the business opportunity lies in disbursing Life Insurance to the remote areas of the country, especially to areas marked as 'difficult to access" by its competitors.

Table 5: Input data, efficiency score and ranking for the year 2012-13

2012-13	CPP {I}	OEX {I}	FA {I}	EPTA {I}	PE {O}	IFI {O}	Eff	Rank
SBI LIFE	0.0493	11510498	2753672	0.0191	103821138	26464519	1.304	6
ICICI PRU	0.0570	20386288	1723984	0.0058	134172372	27992314	1.823	3
RNL	0.0812	12750628	96476	0.0619	40153194	5147265	2.118	2
BSL	0.0595	11597047	342351	0.0818	50517461	10940692	0.976	9
LIC	0.0708	167076628	29721656	0.0001	2085897206	1038821028	1	8
TATA AIA	0.0377	5915745	35202	0.1141	27460398	6931861	4.194	1
ING VYSYA	0.0677	4766912	84980	0.1848	17367175	3545503	1.232	7
BAJAJ ALLIANZ	0.0420	16003010	2518235	0.0039	68926995	13532135	1.441	5
MAX LIFE	0.0935	12288444	1256908	0.0958	65702993	8490974	0.709	11
HDFC	0.0568	13437676	3077176	0.0486	112586292	17787144	0.908	10
KOTAK	0.0431	5732751	316726	0.0469	27239915	5322089	1.66	4

For the year 2012-13 considering the input output combination mentioned above, the most efficient is Tata AIA. Reliance Nippon Life lost its first position; ranked number two, ICICI Pru improved its performance, ranked third. MAX life, HDFC Life and Birla Sun Life continued their poor performance.

Reliance Nippon Life has been awarded with the "Best Non-Urban Coverage" Award at Indian Insurance Awards 2013 for the third time in a row. Reliance has been reaping the benefits of being a recognized and trusted brand in India. They were rated amongst the Top 4 Most Trusted Insurance Brands as per the Brand Equity's 'Most Trusted Service Brands 2013' Survey.

On the other hand, Tata AIA has embarked on the digitization journey early in the industry. Their digital space enables the customers to purchase policies on real time at the click of the button. Tata AIA transacts more than 80 percent of the business through self-service modes. The customers no longer need to make multiple trips to company branches or stand in long queues. The company adopts online process for all claims intimation, tracking, settlement and notification, thereby saving processing cost and time.

Table 6: Input data, efficiency score and ranking for the year 2013-14

2013-14	CPP {I}	OEX {I}	FA {I}	EPTA {I}	PE {O}	IFI {O}	Eff	Rank
SBI LIFE	0.0522	11034315	2861065	0.0170	106571051	30374323	1.329	5
ICICI PRU	0.0511	16168605	2017164	0.0178	122826527	31693174	1.233	7

RNL	0.0775	13271387	151775	0.0642	42567453	6638440	2.350	2
BSL	0.0505	9180154	399243	0.0739	46448513	11758483	1.187	8
LIC	0.0704	237658950	30672993	0.0058	2367980736	1180970850	1	10
TATA AIA	0.0398	4345498	972921	0.1073	23117894	7666757	1.319	6
ING VYSYA	0.0719	4867554	90386	0.1819	18244699	4228169	2.296	3
BAJAJ ALLIANZ	0.0263	13460983	2554847	0.0038	58431389	5467916	3.886	1
MAX LIFE	0.0947	12038354	1179566	0.0782	72118084	10915182	0.829	11
HDFC	0.0429	12807704	3387377	0.0390	119764325	23542092	1.069	9
KOTAK	0.0507	5527881	358297	0.0423	26509372	6547821	1.66	4

For the year 2013-14 considering the input output combination mentioned above, Bajaj Allianz secured top position. Reliance Nippon Life retained second position, ING Vysya stood third. MAX life continued its comparative inefficiency.

Bajaj Allianz has successfully integrated the business strategy with digitalization strategy. They have used Information Technology to streamline every aspect starting from buying life policy and its renewal to registering claims. In this context they have launched a mobile-based application known as INStab that allows their customers to understand the product chosen by them, to book policy, to upload relevant documents, etc. The tool reads out the parameters that the customer has selected in vernacular language and enables customers to make crucial decision in a smart way. The digital platform dramatically reduced costs per policy and cut time to market for new products to just a few weeks.

Table 7: Input data, efficiency score and ranking for the year 2014-15

2014-15	**CPP {I}**	**OEX {I}**	**FA {I}**	**EPTA {I}**	**PE {O}**	**IFI {O}**	**Eff**	**Rank**
SBI LIFE	0.0472	11778258	2714892	0.0138	127799999	36288257	1.286	6
ICICI PRU	0.0365	16520225	2150915	0.0145	151604465	35402718	1.275	7
RNL	0.0611	14799533	308171	0.0645	45916669	7224711	1.429	4
BSL	0.0460	8707124	491661	0.0613	50683663	13521864	1.251	8
LIC	0.0630	223926956	31663937	0.0050	2394827717	1354830928	1	9
TATA AIA	0.0438	4988931	1089660	0.0969	21055896	8623309	1.306	5
ING VYSYA	0.0624	5201469	163586	0.1769	20142066	5022174	2.133	2
BAJAJ ALLIANZ	0.0348	11217426	2271978	0.0035	60172994	6937028	3.66	1
MAX LIFE	0.0924	12418755	1187780	0.0612	81051485	14138562	0.875	11
HDFC	0.0422	14889739	4019633	0.0296	147624515	28608660	0.997	10
KOTAK	0.059	6690607	397257	0.034	29755917	6592212	1.642	3

For the year 2014-15 considering the input output combination mentioned above, Bajaj Allianz retained top position. ING Vysya improved efficiency and stood second. Kotak Life Insurance improved its performance and stood third. MAX life, HDFC Life continued its inefficiency.

Bajaj Allianz believes that customer centricity is the capability to meet customer demands on their terms and pace, irrespective of the time of the day or geographic location. In this context, they launched the mobile branch services at the customer's door-step. The executives proactively service the households around their branch, who are clustered and identified using geo-location; they use a handheld device which is a one-stop shop for all the customer service and payment requirements. They profile the customer, update their nominees and bank details, collect digital mandates and provide policy-related information and receipts on the spot.

The cumulative effect of these restructuring has been an improved operational agility, as reflected in their efficiency score and ranking.

Table 8: Input data, efficiency score and ranking for the year 2015-16

2015-16	CPP {I}	OEX {I}	FA {I}	EPTA {I}	PE {O}	IFI {O}	Eff	Rank
SBI LIFE	0.0456	14581291	4472485	0.0124	156654511	45137006	1.183	8
ICICI PRU	0.0326	18883489	2195346	0.0140	189986971	38169027	1.361	6
RNL	0.0563	13863612	317174	0.0754	43706405	6672747	1.557	3
BSL	0.0403	9042855	64617	0.0603	54117352	16108931	1.335	7
LIC	0.0581	226927657	32105518	0.0000	2662253836	1513382674	1	9
TATA AIA	0.0614	4802813	1136719	0.1002	24357951	9309737	1.503	4
ING VYSYA	0.0680	6563337	280635	0.1663	20162409	5619825	1.452	5
BAJAJ ALLIANZ	0.0270	11086340	2198003	0.0034	58317163	17741984	3.284	1
HDFC	0.0434	18718307	3963745	0.0269	161787796	34725222	0.866	10
KOTAK	0.0660	7941274	440720	0.0305	39132857	7688158	1.797	2

For the year 2015-16, Bajaj Allianz maintained an efficient run and retained top position. Kotak improved its performance and stood second. Reliance Nippon Life stood third. The decline in their ranking may be attributed to the increase in expenses of management (EoM) beyond the permissible limits. The IRDA cautioned the insurer whose actual EoM for 2015-16 was 1,632.24 crore against the limit of 1,069.20 crore. The reasons cited by the company were huge investment in setting up long-term agency distribution, in the absence of bank assurance and the company's experimentation into "non-conventional" areas, with increase in the product portfolio.

Table 9: Input data, efficiency score and ranking for the year 2016-17

2016-2017	CPP {I}	OEX {I}	FA {I}	EPTA {I}	PE {O}	IFI {O}	Eff	Rank
SBI LIFE	0.0376	16464886	5384749	0.0101	208524531	52960366	1.381	4
ICICI PRU	0.034	23571961	2137759	0.012	221552476	41929169	1.300	6
RNL	0.0489	7798369	295002	0.0672	39992557	7139029	1.645	3

BSL	0.0461	7699347	809500	0.0535	55335476	17847067	1.221	7
LIC	0.0553	289446565	25857898	0.0000	3001966840	1640149665	1	8
TATA AIA	0.0849	7354269	1501758	0.0900	31152717	9698765	0.951	9
ING VYSYA	0.0694	5677272	328390	0.1450	23590173	6340727	1.364	5
BAJAJ ALLIANZ	0.0239	10563020	2265025	0.0031	61220988	19408010	3.106	1
HDFC	0.0411	23852810	3529158	0.0219	192748644	40676129	0.826	10
KOTAK	0.064	9281806	618135	0.024	50674584	9213980	1.721	2

For the year 2016-17, Bajaj Allianz, Kotak performed efficiently. TATA AIA and HDFC Life performed inefficiently.

The private players have triumphed over the public sector giant, LIC by cascading sustainable performance-management approach throughout the organization. They have been successful in simultaneously defining new performance metrics and targets, designing new processes along with changing mind-sets and behaviours, and establishing effective performance dialogues. The private players are employing young and energetic team with performance based pay linked to new customer acquisition. They are overhauling the layout of the branches with compact space and low cost operation. Most meeting and new product launches are carried out on the online platform to reduce cost. They also save cost of printing and paper by making communications through emails and making provisions for e-policy and digital lockers. They are also engaging the service of freelance corporate trainers instead of investing on permanent employees for training employees and agents. They are increasingly using the cost effective social media to advertise their product and service. By digitizing the insurance processes, the private players have successfully reduced not only the claims-regulation costs and processing costs, but the processing time as well leading to improved customer service.

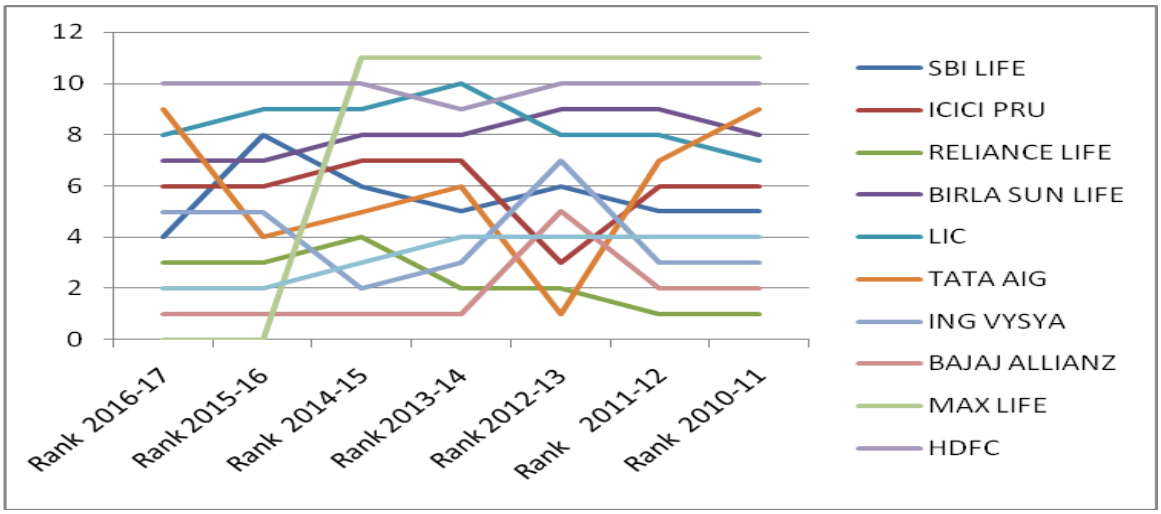

Figure 3. Line chart depicting the ranking of DMUs (Insurance companies) during the period of study.

The years 2010-11 and 2011-12 seemed to be the best for Reliance Nippon Life and from 2013-14 onwards Bajaj Allianz consistently performed with highest efficiency. Throughout the period of study Max Life performed poorly. The poor performing Max Life got merged with HDFC Life, hence for the

year 2015-16 & 2016-17 it has not been taken into consideration as a separate entity. Kotak Life Insurance improved its performance during the period of study.

The analysis highlights LIC as not so efficient for the period of study. The public sector giant, Life Insurance Corporation of India (LIC), though it retained a significant portion of the market share but its operational efficiency has huge scope for improvement. In fact, LIC is slowly losing ground to private players. During the year 2016-17 India issued 264.56 lakh new life insurance policies. Out of these, LIC has issued 201.32 lakh policies (76.1%), while all the private life insurers combined have issued just 63.24 lakh policies (23.9%). However, LIC has registered a decline of 2.02% as compared to previous year, while private players have registered a growth of 2.13%. The private players are not only gaining market share but also trustworthiness among customers with a competitive claim settlement ratio of 93.72% as against 98.31% for LIC in the year 2016-17 **[57]**.

During the year 2016-17, the operating expenses of LIC increased by 27.59 percent and that of private insurers by 6.84 percent as compared to previous year. Private insurance companies are heavily depending on digital revolution and analytics to trim their operating costs. Operating expenses, as a percent of gross premium underwritten increased for LIC from 8.52 percent in 2015-16 to 9.64 percent. The same for private insurers decreased from 16.01percent in 2015-16 to 14.57 percent in 2016- 17 **[57]**. LIC has back-office functions distributed across numerous locations which add to the operating cost. There is huge underutilization of resources with workload backlogs as well. Lack of innovative products that deliver value to customers, an army of agents that gives it enormous distribution leverage, is also staggering. In this digitalisation era LIC has been the last to explore the digital space. Whereas private players are launching innovative products regularly on the online platform, LIC has a limited portfolio of products that are available online. In the year 2016-17, private players acquired 1.13 % of their new premium through online, while LIC could only manage to garner 0.12% of the new premium through online platform. While private players are going full swing to cater to customers at their doorstep, LIC is overburdened with pack of vintage employees who are complacent. LIC has also spent huge amounts in overhauling these employees to adapt to the new computer age .Hence, it has to tackle both high IT spending and low productivity. While the whole sector is promoting quick purchase and renewal of policies and registration of claim on the click of a button, LIC is trapped in plethora of paper works and formalities.

Table 10: Channel-wise individual business performance of life insurers for 2016-17

Life Insurer	**Individual Agents**	**Corporate Agents Banks**	**Others**	**Brokers**	**Direct Selling**	**MI Agents**	**Common Service Centre's**	**Web Aggregators**	**IMF**	**Online**	**Point of Sales**	**Total Individual New Business**	**Referrals**
Private LIC	30.09 95.99	53.50 2.39	3.01 1.00	2.98 0.04	9.11 1.33	0.01 0.03	0.005 0.00	0.14 0.00	0.04 0.00	1.13 0.12	0.00 0.00	100 100	0.08 0.00
Industry Total	68.79	23.48	1.30	1.25	4.54	0.02	0.002	0.06	0.02	0.54	0.00	100	0.03

Source: IRDAI annual report 2016-17 **[57]**

In the arena of distribution, private players are exploring innovative channels such as corporate agents, bank assurance, web aggregators, agency partner channel, point of sale agents etc. Bank assurance is slowly emerging as the primary distribution channel among private insurers, with 53% share in 2016 from

21% in 2010. LIC continues to rely on the traditional channel of individual agents generating 95.99% of the new business premium through them in the year 2016-17.

Table 11: DMU and peer companies

	2016-17		**2015-16**		**2014-15**		**2013-14**		**2012-13**		**2011-12**		**2010-11**	
DMU	**Peer**	**Lambda**	**Peer**	**Lambda**	**Peer**	**Lambda**	**Peer**	**Lambda**	**Peer**	**Lambda**	**Peer**	**Lambda**	**Peer**	**Lambda**
SBI Life	Bajaj Allianz	0.1731	Bajaj Allianz	0.2470	Bajaj Allianz	0.1437	Bajaj Allianz	0.1107	ICICI Pru	0.5227	Bajaj Allianz	0.3999	Bajaj Allianz	0.2588
	ICICI Pru	0.7257	ICICI Pru	0.5306	ICICI Pru	0.5843	ICICI Pru	0.6233	Kotak	0.4673	Kotak	0.5583	Kotak	0.7001
	Birla Sun Life	0.0905	Kotak	0.2099	Kotak	0.2625	Kotak	0.259	LIC	0.0100	LIC	0.0418	LIC	0.0412
	LIC	0.0107	LIC	0.0125	LIC	0.0095	LIC	0.007						
ICICI Pru	Bajaj Allianz	0.4568	Bajaj Allianz	0.4752	Bajaj Allianz	0.5041	Bajaj Allianz	0.4951	Bajaj Allianz	0.8081	Bajaj Allianz	0.4009	Bajaj Allianz	0.0168
	Reliance Life	0.0462	Birla Sun Life	0.1009	Birla Sun Life	0.0466	Kotak	0.4706	Kotak	0.1563	SBI Life	0.2143	SBI Life	0.677
	Kotak	0.4406	Kotak	0.3704	Kotak	0.4047	LIC	0.0344	LIC	0.0356	Reliance Life	0.3544	Kotak	0.2661
	LIC	0.0564	LIC	0.0535	LIC	0.0446					LIC	0.0305	LIC	0.0400
Reliance Life	Exide	0.7147	Kotak	0.9697	Exide	0.1561	Exide	0.1376	Tata AIA	0.4495	Exide	0.0681	Birla Sun Life	0.9220
	Kotak	0.2823	ICICI Pru	0.0303	Birla Sun Life	0.8439	Birla Sun Life	0.8624	Birla Sun Life	0.5505	Birla Sun Life	0.9319	ICICI Pru	0.0780
	LIC	0.0029												

Exide	Tata AIA	0.1266	Reliance Life	0.2685	Reliance Life	0.543	Reliance Life	0.7298	Tata AIA	0.7533	Tata AIA	0.5976	Reliance Life	0.5929
	Reliance Life	0.8734	Kotak	0.7315	Kotak	0.457	Kotak	0.2702	Kotak	0.2467	Reliance Life	0.4024	Kotak	0.4071
Birla Sun Life	Bajaj Allianz	0.29	Bajaj Allianz	0.2007	Tata AIA	0.085	Reliance Life	0.3434	Tata AIA	0.4689	Tata AIA	0.4466	Exide	0.0949
	Exide	0.2184	Exide	0.2591	Exide	0.19	Kotak	0.6505	Reliance Life	0.4151	Reliance Life	0.4477	Reliance Life	0.4865
	Reliance Life	0.4871	Reliance Life	0.4585	Reliance Life	0.3886	LIC	0.0062	ICICI Pru	0.1132	ICICI Pru	0.0492	Kotak	0.4134
	LIC	0.0045	ICICI Pru	0.0108	ICICI Pru	0.0739			LIC	0.0028	Kotak	0.0524	LIC	0.0052
			Kotak	0.0662	Kotak	0.2591					LIC	0.0042		
			LIC	0.0047	LIC	0.0035								
Tata AIA	Exide	0.3503	Exide	0.8856	Exide	0.6038	Exide	0.0853	Reliance Life	0.9983	Reliance Life	0.2333	Exide	0.0901
	Birla Sun Life	0.6497	Kotak	0.1121	Birla Sun Life	0.2603	Kotak	0.9136	LIC	0.0017	Kotak	0.7656	Reliance Life	0.1397
			LIC	0.0023	Kotak	0.0964	LIC	0.0011			LIC	0.0011	Kotak	0.7273
					SBI Life	0.0396							ICICI PRU	0.043
Bajaj Allianz	SBI Life	0.9401	SBI Life	0.9006	SBI Life	0.8622	SBI Life	0.8178	ICICI Pru	0.9818	ICICI Pru	0.7414	ICICI Pru	0.8071

	LIC	0.0599	LIC	0.0994	LIC	0.1378	LIC	0.1822	LIC	0.0182	LIC	0.2586	LIC	0.1929
HDFC	Bajaj Allianz	0.1353	Bajaj Allianz	0.1058	SBI Life	0.5139	Tata AIA	0.2935	Exide	0.053	Exide	0.0184	SBI Life	0.1103
	SBI Life	0.2438	SBI Life	0.428	ICICI PRU	0.4824	SBI Life	0.5708	LIC	0.0067	LIC	0.0014	Kotak	0.5593
	Birla Sun Life	0.0236	ICICI Pru	0.4662	LIC	0.0037	Bajaj Allianz	0.1166	SBI Life	0.9403	Kotak	0.2927	ICICI Pru	0.3303
	ICICI Pru	0.5972					LIC	0.0191			SBI Life	0.6876		
Kotak	Bajaj Allianz	0.3766	Bajaj Allianz	0.0942	Bajaj Allianz	0.1236	Tata AIA	0.0237	Tata AIA	0.4439	Tata AIA	0.5764	Exide	0.1924
	Reliance Life	0.6086	Birla Sun Life	0.9058	Reliance Life	0.3233	SBI Life	0.0746	SBI Life	0.1715	SBI Life	0.1669	Birla Sun Life	0.6319
	ICICI Pru	0.0148			Birla Sun Life	0.5531	Birla Sun Life	0.9017	Reliance Life	0.3846	Reliance Life	0.2567	SBI Life	0.1756
LIC	Infeasible		Infeasible		Infeasible		Infeasible		Infeasible		Infeasible		Infeasible	

The **table 11** represents different companies along with their peers. The reference units are given for each of the DMUs along with the respective dual weights in table. The dual weights can be used to compute the reduced value of the hypothetical composite unit for any input. The inefficient unit has to follow the reference units and reduce its inputs to a level indicated by the reduced values so that it is rendered efficient. For the year 2016-17 if we consider SBI Life, it has 4 reference units Bajaj Allianz, ICICI Pru, Birla Sun Life and LIC. It has to follow these peers in order to improve its efficiency and move to the efficient frontier. The dual weight of reference unit ICIC Pru (0.7257) is much larger than that of LIC (0.0107) indicating that unit ICICI Pru has a stronger influence in determining the ideal performance of SBI Life.

LIC appears as peers for almost every private players in the year 2016-17 and can be considered as a global leader as it influences every inefficient private life insurance company. This is quite evident because every private player has entered the market following the footprints of LIC. On the other hand, HDFC Life does not act as reference unit for any of the life insurance players for the year 2016-17. This highlights that HDFC Life is efficient only in a very narrow sector. This is obvious from the not so impressive performance of HDFC Life in all the years included in the study.

6. **Comparative Analysis**

Table 12: Ranking of Life Insurance companies using MCDM techniques during 2010-11

2010-11	**RANKING**						
COMPANIES	**TOPSIS**	**ROVM**	**ARAS**	**MARCOS**	**SAW**	**WSM**	**WASPAS**
SBI life	4	3	3	6	6	4	6
ICICI PRU	2	1	1	5	5	3	5
RNL	6	8	8	4	4	5	4
BSL	7	7	7	8	8	7	8
LIC	1	4	4	1	1	1	1
Tata AIG	9	9	9	7	7	10	7
ING Vysya	11	11	11	2	2	9	2
Bajaj Allianz	3	5	5	10	10	2	10
Max Life	10	10	10	11	11	11	11
HDFC	8	6	6	9	9	8	9
Kotak	5	2	2	3	3	6	3

Table 13: Ranking of Life Insurance companies using MCDM techniques during 2011-12

2011-12	**RANKING**						
COMPANIES	**TOPSIS**	**ROVM**	**ARAS**	**MARCOS**	**SAW**	**WSM**	**WASPAS**
SBI life	2	1	1	6	6	3	6
ICICI PRU	3	2	2	8	8	4	8
RNL	6	9	9	4	4	5	4
BSL	8	8	8	7	7	7	7
LIC	1	5	5	1	1	1	1
Tata AIG	9	6	6	5	5	8	5
ING Vysya	11	11	11	2	2	10	2
Bajaj Allianz	4	4	4	9	9	2	9
Max Life	10	10	10	11	11	11	11
HDFC	7	7	7	10	10	9	10
Kotak	5	3	3	3	3	6	3

Table 14: Ranking of Life Insurance companies using MCDM techniques during 2012-13

2012-13	**RANKING**						
COMPANIES	**TOPSIS**	**ROVM**	**ARAS**	**MARCOS**	**SAW**	**WSM**	**WASPAS**
SBI life	4	3	3	6	6	5	6
ICICI PRU	2	4	4	10	10	2	10
RNL	7	9	9	7	7	7	7
BSL	8	8	8	8	8	8	8
LIC	1	5	5	1	1	1	1
Tata AIG	9	6	6	2	2	3	2
ING Vysya	11	10	10	3	3	10	3
Bajaj Allianz	3	1	1	5	5	4	5
Max Life	10	11	11	11	11	11	11
HDFC	6	7	7	9	9	9	9
Kotak	5	2	2	4	4	6	4

Table 15: Ranking of Life Insurance companies using MCDM techniques during 2013-14

2013-14	RANKING						
COMPANIES	**TOPSIS**	**ROVM**	**ARAS**	**MARCOS**	**SAW**	**WSM**	**WASPAS**
SBI life	5	3	3	8	8	3	8
ICICI PRU	3	2	2	10	10	2	10
RNL	8	9	9	6	6	8	6
BSL	7	7	7	7	7	6	7
LIC	1	6	6	1	1	1	1
Tata AIG	9	8	8	4	4	10	4
ING Vysya	11	11	11	3	3	9	3
Bajaj Allianz	2	1	1	2	2	4	2
Max Life	10	10	10	11	11	11	11
HDFC	6	4	4	9	9	7	9
Kotak	4	5	5	5	5	5	5

Table 16: Ranking of Life Insurance companies using MCDM techniques during 2014-15

2014-15	RANKING						
COMPANIES	**TOPSIS**	**ROVM**	**ARAS**	**MARCOS**	**SAW**	**WSM**	**WASPAS**
SBI life	4	3	3	8	8	3	8
ICICI PRU	2	2	2	7	7	2	7
RNL	8	9	9	9	9	8	9
BSL	7	6	6	6	6	5	6
LIC	1	5	5	1	1	1	1
Tata AIG	10	8	8	4	4	11	4
ING Vysya	11	11	11	2	2	10	2
Bajaj Allianz	3	1	1	3	3	4	3
Max Life	9	10	10	11	11	9	11
HDFC	6	4	4	10	10	6	10
Kotak	5	7	7	5	5	7	5

Table 17: Ranking of Life Insurance companies using MCDM techniques during 2015-16

2015-16	RANKING						
COMPANIES	**TOPSIS**	**ROVM**	**ARAS**	**MARCOS**	**SAW**	**WSM**	**WASPAS**
SBI life	4	3	3	9	9	4	9
ICICI PRU	3	2	2	8	8	3	8
RNL	8	8	8	3	3	8	3
BSL	7	5	5	6	6	6	6
LIC	1	6	6	1	1	1	1
Tata AIG	9	9	9	4	4	9	4
ING Vysya	10	10	10	2	2	10	2
Bajaj Allianz	2	1	1	7	7	2	7
HDFC	6	4	4	10	10	5	10
Kotak	5	7	7	5	5	7	5

Table 18: Ranking of Life Insurance companies using MCDM techniques during 2016-17

2016-17	RANKING						
COMPANIES	**TOPSIS**	**ROVM**	**ARAS**	**MARCOS**	**SAW**	**WSM**	**WASPAS**
SBI life	4	3	3	9	9	4	9

ICICI PRU	3	2	2	8	8	3	8
RNL	8	8	8	3	3	8	3
BSL	7	6	6	5	5	6	5
LIC	1	4	4	1	1	1	1
Tata AIG	9	9	9	7	7	10	7
ING Vysya	10	10	10	2	2	9	2
Bajaj Allianz	2	1	1	4	4	2	4
HDFC	6	5	5	10	10	5	10
Kotak	5	7	7	6	6	7	6

Table 19: Correlation between MCDM techniques and DEA

	TOPSIS	**ROVM**	**ARAS**	**MARCOS**	**SAW**	**WSM**	**WASPAS**	**DEA**
TOPSIS	1.00	.836	.836	.227	.227	.941	.227	.077
ROVM	.836	1.00	1.00	.109	.109	.723	.109	-.123
ARAS	.836	1.00	1.00	.109	.109	.723	.109	-.123
MARCOS	.227	.109	.109	1.00	1.00	.318	1.00	.027
SAW	.227	.109	.109	1.00	1.00	.318	1.00	.027
WSM	.941	.723	.723	.318	.318	1.00	.318	.273
WASPAS	.227	.109	.109	1.00	1.00	.318	1.00	.027
DEA	.077	-.123	-.123	.027	.027	.273	.027	1.00

Table 20: The pattern matrix

	Component		
	1	2	3
TOPSIS	.942		
ROVM	.982		
ARAS	.982		
MARCOS		1.004	
SAW		1.004	
WSM	.842		
WASPAS		1.004	
DEA			.990

In **table 19.** the correlation matrix depicts high correlation between ranks obtained through TOPSIS, ROVM, ARAS and WSM, similarly high correlation is observed between MARCOS, SAW and WASPAS. The pattern matrix represented in table 20 confirms group wise association among these MCDM techniques due to varying internal analytics. It further shows that DEA stands out **[50]** among these techniques being a Mathematical Programming based optimization method.

7. CONCLUSIONS

The common perception is that LIC being the market leader is also the efficient DMU. But the extensive analysis in the paper points out that the smaller players have more potential and are doing better than the leader in the efficiency frontier considering the given set of inputs and outputs. As envisaged by the paper a public sector undertaking like LIC, biggest player of the country in insurance industry, lacks the efficiency and niche of a top private player in its segment. However LIC has the trust of the common man along with biggest network of agents which enables it to retain the first position in terms of volume. A

few private players though efficient have a long way to go in instilling confidence in the mind of common people. With time the efforts of the smaller players will magnify into larger volume of business for them. The reference table points out LIC as the supreme leader and though it has fallen behind others in this digital age, the private players have lot to learn from LIC in terms of trust, magnitude, outreach and portfolio of products. This paper used DEA and SEM to evaluate the efficiency of multiple Life Insurance companies. Further MCDM techniques are used to obtain ranking and comparative analysis is conducted to observe the variation in ranking. The rankings obtained through various other techniques again points out DEA as a superior standalone technique of ranking and validates the methodology used in the study. The findings gained in this research may provide future reference to the researcher.

8. LIMITATIONS & FUTURE SCOPE

In this research work efficiency measurement based on specified inputs and outputs has been done. The choice of inputs and outputs affects efficiency scores and the results will differ with different sets of attributes in terms of inputs and outputs **[58-68]**. The data is restricted to 7 years only. Keeping in mind the homogeneity for comparison the Life insurance companies have been also restricted to 11 companies. In future, the number of insurance companies under study can be extended to cover entire Life Insurance industry by relaxing the homogeneity condition. Furthermore, the duration of study and area of application can be further updated.

In future, researchers may explore the analytical reasons for the variation in ranking obtained by DEA and other MCDM tools. Sensitivity analysis can be carried out by considering output oriented model where the objective is to maximize output instead of reduction of input.

The research can be further expanded to explore the leaders among the private life insurance companies only, excluding LIC. A detailed peer review may also be carried out to discover the parameters in transforming the inefficient units into efficient ones. Window analysis can be carried out in future.

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Code availability: R 3.6.3 & Amos 22.0.

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