# AN EFFICIENCY ANALYSIS OF INDIAN REINSURERS AND GENERAL INSURERS USING DATA ENVELOPMENT ANALYSIS

**Thesis Submitted**
**In partial fulfillment of the Requirements for the Degree of**

## MASTER IN TECHNOLOGY

**in**

**Industrial Engineering and Management**

**by**

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**(2K23/IEM/01)**

**Under the Supervision of**

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**May 2025**

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**(4)** Degree for which the thesis is submitted: **M.Tech.**
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Total Pages: 65

Name of the Scholar: **Ravi Ranjan**

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# ACKNOWLEDGEMENTS

Foremost, I immensely thank Almighty for the wisdom, blessings and inspiration throughout this research work.

I embrace the opportunity to express my deep sense of gratitude to my supervisor **Pravin Kumar, Professor**, Department of Mechanical Engineering, Delhi Technological University, Delhi, for his constant guidance, valuable suggestions and encouragement during this research. His encouragement, support, intellectual stimulation, perceptive guidance, immensely valuable ideas, and suggestions from the initial to the final level enabled me to develop an understanding of the subject. His scholarly suggestions, constant help and affectionate behavior have been a source of inspiration for me. I am extremely grateful to him for his continuous guidance.

I am cordially thankful to the **Prof. Prateek Sharma, Hon'ble Vice-Chancellor**, Delhi Technological University, Delhi for providing this world class platform to conduct this research work. My acknowledgement will never be complete without the special mention of **Prof. S.K.Garg,** Professor, Delhi Technological University and **Prof. B.B. Arora, HOD** Department of Mechanical Engineering, Delhi Technological University, Delhi.

I am thankful to Central library, Delhi Technological University for providing me the access to world class research literature that helped me in this research work.

I am highly thankful to Mr. Gaurav Mishra, Research Scholar, Department of Mechanical Engineering, Delhi Technological University, Delhi and Mr. Roshan Kumar, Technical Assistant, Industrial Engineering Lab, Department of Mechanical Engineering, Delhi Technological University, Delhi for assisting in this research work.

I am thankful to all the authors and publishers whose research work has helped me in this research project.

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# An Efficiency Analysis Of Indian Reinsurers And General Insurers Using Data Envelopment Analysis

**Ravi Ranjan**

## ABSTRACT

This research investigates the operational and productivity efficiency of Indian general insurers and reinsurers using Data Envelopment Analysis (DEA) and the Malmquist Productivity Index (MPI) over four year from 2020 to 2024 and five-year period from 2019 to 2024 respectively. The study evaluates 27 general insurers and 11 reinsurers, combining both public and private sector entities, to provide a comprehensive picture of performance across the insurance ecosystem.Two DEA models, Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) were used to measure technical, pure technical, and scale efficiencies. Inputs such as operating expenses and equity were assessed against outputs like net premiums earned and income from investments. The results revealed significant variation in efficiency. Public sector entities like The New India Assurance and GIC Re achieved perfect efficiency scores (1.0) across all years, indicating optimal resource utilization and scale. Conversely, newer private players such as Acko General (mean score 0.152) and Navi General (mean score 0.347) demonstrated considerable inefficiencies, largely due to scale disadvantages and inconsistent operations.The Malmquist Index further revealed that most productivity improvements were driven by technological progress rather than managerial efficiency gains. While firms are investing in innovation, they struggle to translate it into consistent operational performance.This study highlights the need for strategic reforms focused on scale optimization, internal management practices, and customer service infrastructure. The findings offer critical insights for regulators like IRDAI, policymakers, and insurance firms aiming to boost sectoral efficiency, support financial inclusion, and strengthen the resilience of India's risk transfer mechanisms.

**Keywords:** Data Envelopment Analysis, Malmquist Index, Technical Efficiency, Indian Insurance Sector, Reinsurers

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# LIST OF ABBREVIATIONS

| Abbreviation | Full Form |
|---|---|
| AUM | Assets Under Management |
| BCC | Banker, Charnes, and Cooper (DEA model under Variable Returns to Scale) |
| CCR | Charnes, Cooper, and Rhodes (DEA model under Constant Returns to Scale) |
| CRS | Constant Returns to Scale |
| CSR | Claim Settlement Ratio |
| GRR | Grievance Resolution Rate |
| DEA | Data Envelopment Analysis |
| DMU | Decision-Making Unit |
| ESG | Environmental, Social, and Governance |
| GIC Re | General Insurance Corporation of India Reinsurance |
| IRDAI | Insurance Regulatory and Development Authority of India |
| LIC | Life Insurance Corporation |
| MPI | Malmquist Productivity Index |
| PTE | Pure Technical Efficiency |
| TE | Technical Efficiency |
| RGA | Reinsurance Group of America |
| SBM | Slacks-Based Measure |
| SE | Scale Efficiency |
| VRS | Variable Returns to Scale |
| FY | Financial Year |
| TECHCH | Technological Change |
| EFFCH | Efficiency Change |
| TFPCH | Total Factor Productivity Change |

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Insurance and reinsurance play an important role in keeping an economy financially stable. They help people, companies, and markets manage risk by sharing and spreading it. In India, these sectors have changed a lot over the years, especially due to major rules and policy changes that have shaped how they work today. Ever since the insurance sector opened up in 1999 and the reinsurance market was deregulated in 2016, the industry has seen a major transformation. What was once a government-dominated setup has now become a competitive space with many private players. This shift has led to more choices for customers, better services, and new innovations focused on meeting people's needs. These changes create an opportunity for domestic private firms, which are not allowed earlier. It also increases the partifipation of global insurance companies and creating a competitive, and performance-driven industry which focusses not only on quantity but also on service quality .

As India's economy is growing year by year and also it get modernize , therefore the insurance ecosystem should also be robust and strong to support the long-term risk management. Due to cases like COVID-19 pandemic, rising climate-related disasters, and increasing digitalisation ,insurance industries have pressure to operate efficiently and providing better service quality to their customers. Traditional measures like profit ratio or return on investment alone have not captures full picture of these industries Although these are useful but offer only a partial perspective. A more nuanced understanding of performance is required for these type of complex industries. The requirement of approach which can handle multiple inputs and outputs. An approach

which can track productivity changes over time, and distinguish between managerial inefficiency and issues related to scale.

That is why more and more researchers and professionals are now using non-parametric methods like Data Envelopment Analysis (DEA) and the Malmquist Productivity Index to study efficiency and performance. With the help of DEA Wwe gwt a powerful framework to evaluate relative efficiency by comparing firms treated as decision-making units (DMUs) that consume similar types of inputs to produce comparable outputs. DEA models uses two types of assumption first is constant returns to scale (CRS) under which we consider both pure technical efficiency and second one is variable returns to scale (VRS) under which we consider only scale effect ,both assumptions allows analysts to make different analysis and measure pure technical efficiency and scale-related efficiency. Integration of these analysis with the Malmquist Productivity Index, increases the effectiveness because MPI decomposes total productivity growth into changes in technical efficiency and technological progress, and enhances the insight by analysing productivity change over multiple years.

This study uses DEA and Malmquist productivity models over a defined time period and analyse the general insurance sector and reinsurance sector separately. The time frame for general insurance evaluation is from 2020 to 2024 and for reinsurance companies is from 2019 to 2024. This period faces significant amount of changes or events such as the global health crisis like COVID19 happened in this period. Shifts in digital adoption that is many firms and customers shifted from physical operations to digital operations during this period and evolving regulatory standards in insurance industries, which is issued by the Insurance Regulatory and Development Authority of India (IRDAI), increases customer trust in insurance field. These reasons make this insurance sectors being competitive and fast growing.

For this research work, we have taken secondary data from IRDAI's annual reports and financial handbook published by IRDAI in February 2024 for various insurers and reinsurers. Inputs and outputs are selected from these data variables by doing different statistical techniques such as correlation analysis which is done separately on

all probable inputs and outputs, ensuring that the DEA model remains both rigorous and meaningful. Lator on regression analysis on ouput in respect of different key inputs are done and based on significance results selection of outputs are done. The main input factors in this analysis are operating expenses, commission payments, and equity. On the other hand, the key outputs are net premiums earned and income from investments, which are considered the two main indicators of how much business is being done and how well the company is performing financially.

Observations in analysis gives noticeable differences in how various firms are performing especially when comparing different sector like public vs. private companies, and domestic vs. international players. GIC reinsurance, the government-owned reinsurance company, has consistently demonstrated strong technical efficiency, which is due to its large-scale operations and many years of experience in the industry. Opposite of this many insurance industries which are new in this sector despite having fresh ideas and innovation they often face challenges in streamlining their operations. This is largely because they operate at a smaller scale and haven't yet built the kind of operational maturity that experienced firms have adopted. A similar trend can be seen in the general insurance segment as well where an established companies continue to run efficiently, while others face ups and downs due to unstable cost structures or poor utilization of resources.

This study uses DEA and the Malmquist Productivity Index to analyse factors which truly responsible for growth in the insurance industries or what truly drives efficiency in India's insurance and reinsurance sectors. It looks at how factors like company size (whether firm is too small or too large ), areas of operation influence performance. The goal is to offer clear, practical insights that can support stronger business strategies, guide policy decisions, and inspire further academic research. As the industry faces growing pressure to innovate, control costs, and deliver greater value to customers is a necessity for survival and growth.

## 1.2 Research Gap and Contribution

### 1.2.1 Research Gap

There are a number of studies that have assessed the efficiency of Indian insurance firms using Data Envelopment Analysis (DEA), the literature on a large scale focusing exclusively on life insurance but with little effort to evaluate as a whole efficiency of all general insurance which are further divided into private ,public and stand alone health insurance. There are also less number of papers which have focused on reinsurance sectors in India. Moreover, most of these studies adopt a static perspective and fail to incorporate time-based productivity changes, such as those induced by regulatory transitions, technological innovations. Additionally, prior research has not adequately defined on what basis they have selected their inputs and outputs. This creates a significant gap in understanding the dynamic drivers of efficiency, the impact of ownership structure, and the optimal scale of operation for different types of insurers.

### 1.2.2 Research Objective

This study aims to conduct an efficiency evaluation of Indian general insurers and reinsurers using both traditional DEA and the Slacks-Based Measure (SBM) model, under constant and variable returns to scale. The objectives are :

1. To measure and compare the technical, pure technical, and scale efficiencies of both public and private firms in the insurance and reinsurance sectors.
2. Along with efficiency analysis, with the help of the Malmquist Productivity Index, productivity changes over time is analysed which captures both managerial efficiency shifts and technological progress.
3. To generate actionable insights for regulators, policymakers, and business leaders to make better decisions. The objective is to clearly differentiate between challenges arising from a company's internal lagging factors such as inefficient resource utilization or weak management and those caused by external structural factors like constraints related to the company's scale or operational capacity.

# CHAPTER 2

# LITERATURE SURVEY

## 2.1 Literature Review

Operational efficiency is one of important measurement factors in the insurance industries in past two decades. After liberalization of insurance industry and rising competition among insurance and banking industries specially financial sectors, it gained quite attention. Earlier traditional methods used to gain insight about performance in these sectors, but these methods have not provided whole picture or we can say deeper insight of efficiency. To assess the performance like how much efficient is a firm when multiple variables are considered, it often fail to provide a complete picture of efficiency. Since these traditional methods also analyse only single inputs and single output , therefore we required an advance approach which can handle multiple inputs and multiple outputs and evaluate the efficiency and compare different companies. Taking these factors in consideration , researchers have developed a non-parametric methods like Data Envelopment Analysis (DEA), which allows for the assessment of multiple inputs and outputs simultaneously, offering a more holistic approach to performance evaluation.

The pioneered work in the sector of DEA has started by (Charnes et al., 1978) who introduces a model under the assumption of constant returns to scale (CRS). Lator on the model developed by Charnes was further expanded by (Banker Rajiv D. et al., 1984) which was under the Variable Returns to Scale (VRS) model to separate pure technical efficiency from scale efficiency. This medhodology is more advanced than traditional efficiency methods which consider more subtle analysis and it is more

useful for solving complex and tedious field in financial sectors like insurance and banks, where firm size and operational scale vary widely.

If we talk about application of DEA in international analysis we analyse (Biener & Eling, 2012) paper under which they examined the organizational structure and efficiency of insurers in Europe and North America. Their study clearly showed that who owns the company plays a big role in how efficiently it runs. This finding supports the idea that a company's ownership setup can directly impact its overall performance. Similarly,(Cummins et al., 2010) who has focused on the U.S. insurance industry and it was found that companies focusing on a specific area tend to work more efficiently than those trying to manage many different businesses under one roof. This finding was more supported by (Berger et al., 2000) who argued that firms which are more focused on their core competencies other than focusing on multiple or diverse business tend to perform better.

In the Indian insurance sector, after the liberalization of insurance a large amount of studies has been carried out by researcher in the field of evaluating efficiency of financial sectors. (Ilyas & Rajasekaran, 2019) conducted a study using bootstrapped DEA and the Malmquist Productivity Index on Indian general insurers. The study found that government-owned insurance companies were usually better at keeping costs under control. However, private insurers stood out for being more flexible and quicker to bring in new ideas and innovations. (Bawa & Ruchita, 2011) considered evaluating the performance of health insurers and highlighted that Insurers that focus on a specific area often do better because their operations are more targeted, and their services are simpler, faster, and easier to manage. (Siddiqui, 2022) has done evaluation of health insurance by applying SBM-DEA and find out that there is a large area for improvement in management in insurance sectors to improve their operational and technical efficiency.

Lator on other DEA methodologies has also led to more sophisticated analyses. (Raj et al., 2023) analysed Indian reinsurance sectors using a three-stage fuzzy DEA approach to evaluate the performance. They find that inefficiencies in Indian reinsurance companies is more due to scaling or firm size factors and not due to

managerial inefficiencies. This earlier work was supported by (Kapil Raj et al., 2024), who applied fuzzy DEA models to public sector general insurers and it highlighted how important it is to account for the uncertainty in real-world financial data, helping decisions stay realistic and grounded in reality.

(Sinha, 2021) in their research used two-stage DEA to compare operational and financial efficiencies among Indian general insurers. His findings revealed that a company's ownership and type played a big role in how well it performed, especially when looking at changing productivity over time, (Färe Rolf et al., 1994) introduced the Malmquist Productivity Index, which breaks down productivity changes into efficiency change and technological progress. Over time, this model has become go to method for researchers means researchers used this method commonly when studying changes and patterns in data collected over long periods. (Shieh et al., 2020), for example, used the Malmquist Index to compare insurance firms in Mainland China and Taiwan, highlighting showing how different rules and regulations impact their efficiency over time.

Talking about the implementation of DEA methodology in the South Asian and BRIC countries, (Huang & Eling, 2013) looked at non-life insurance companies and found that big-picture economic factors have a major impact on how efficiently they operate. It showed that insurers in well-developed and stable economies usually perform better. This is mainly because they have easier access to resources and benefit from stronger, more supportive regulations. (Nandi, 2014) studied Indian life insurers using DEA and found that public sector firms like LIC often done better and mostly efficient in all years in comparison to private firms in terms of technical efficiency. (Sinha, 2007) used the Assurance Region DEA model to highlight how liberalization and modernization have helped Indian insurance companies grow and improve the way they operate and manage their business.

(Amir et al., 2013) utilized stochastic frontier analysis to study insurers in Malaysia and found that despite there is key role of technology in the improvement of efficiency and also technological advancement is improving in the companies but companies often struggled with internal management which becomes a factor of declining

efficiency.This is generally with Indian insurance companies which adopted technology quickly and think it enhances the efficiency but never focused on internal management. (Yang, 2006) and (Jalili Sabet & Fadavi, 2013) used and tested two-stage DEA models, which showed that problems in main operations often lead to weak financial results, highlighting the need for overall efficiency improvements.

The existing research offers a wide variety of ways to study efficiency in the insurance and reinsurance industries. This study has used DEA and Malmquist models to look at both general insurers and reinsurers in India. By doing so, it gives a clearer and more complete picture of how these companies are performing and growing over time.

## 2.2 Bibliometric Analysis

Bibliometric analysis is popular method utilized to review and analyse scientific literature as discussed by (Merigó & Yang, 2017). In this study we have utilized bibliometrix R-package created by (Aria & Cuccurullo, 2017).

This study utilizes SCOPUS database as the search database to ensure the quality of reviewed literature. To ensure that only relevant literature is reviewed we have used keywords “dea”, “insurance ”, “efficiency”. The first search with input keywords “insurance ” gave about 367,818 results. To narrow down the search and keep the relevant literature we added the keyword “efficiency” to the search gave 9,895 . The modified search input “DEA” AND “Insurance” AND “efficiency” lead to 303 results. The search period was set from 2005 to 2025.We have selected articles ,conference papers and review papers. This set of research works is used for the bibliometric analysis. COVID-19 pandemic has been a major reason for breakthrough and transformation in the field of insurance sector.

Table 2.1 bibliometric summary offers an overview of research output on Data Envelopment Analysis (DEA) from 2005 to 2025. Over this 20-year span, 300 documents have been produced across 217 sources, reflecting a healthy annual growth

rate of 13.23%. A total of 722 authors contributed to this field, with only 39 single-authored papers, indicating a strong collaborative trend. Each document, on average, involved nearly three co-authors, and 27% of the works featured international collaboration. The dataset includes 764 distinct author keywords, suggesting a wide range of thematic focus areas. The average age of documents is 7.22 years, with each paper receiving an average of 24.51 citations, underscoring the academic impact and relevance of the literature. Although references are not shown here, the data collectively highlight an active and increasingly global scholarly community engaged in advancing efficiency and performance evaluation using DEA methodologies.

## Table 2.1. Information of literature

| **Main Information About Data** | **Detail** |
|---|---|
| Timespan | 2005:2025 |
| Sources (Journals, Books, etc) | 217 |
| Documents | 300 |
| Annual Growth Rate % | 13.23 |
| Document Average Age | 7.22 |
| Average citations per doc | 24.51 |
| References | 0 |
| DOCUMENT CONTENTS | |
| Keywords Plus (ID) | 1099 |
| Author's Keywords (DE) | 764 |
| AUTHORS | |
| Authors | 722 |
| Authors of single-authored docs | 39 |
| AUTHORS COLLABORATION | |
| Single-authored docs | 44 |
| Co-Authors per Doc | 2.95 |
| International co-authorships % | 27 |
| DOCUMENT TYPES | |
| article | 269 |
| article article | 2 |
| conference paper | 27 |
| review | 1 |
| review article | 1 |

Fig. 2.1 depicts a brief summary of literature on efficiency analysis using DEA. From 2005 to 2025 there is approximately 13.23% of annual growth and international co-authorship of 27% in scientific literature related to efficiency analysis using DEA.

Fig. 2.2 depicts a chart on the annual scientific output in terms of article publications from 2005 to 2025. A gradual increase is observed from 2005, with noticeable fluctuations across the years.

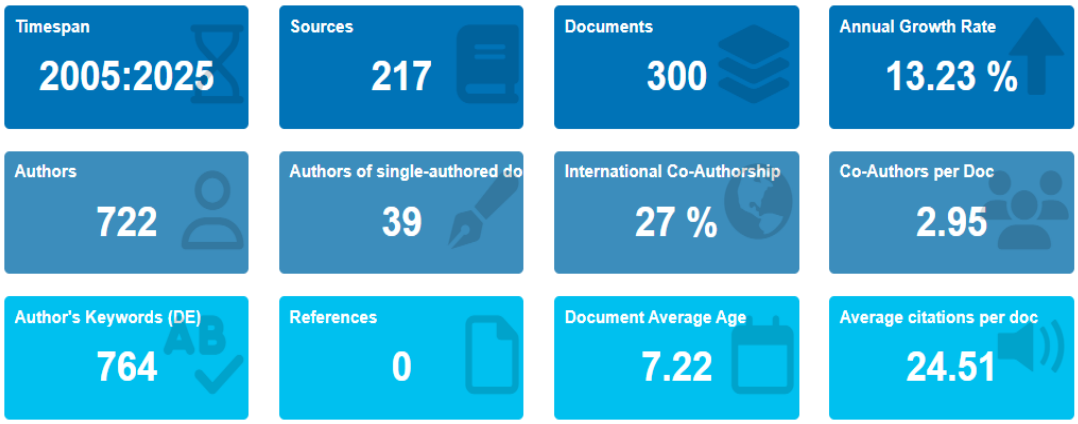


Fig.2.1. Overview of literature on DEA insurance efficiency.

Peaks are evident around 2013, 2015, 2020, and the highest in 2023, indicating growing academic interest during these periods. The dip in 2024 suggests either a delay in indexing or reduced publication volume. Overall, the trend reflects a significant upward trajectory in research activity, particularly in recent years, highlighting increasing scholarly engagement in the field of insurance, efficiency, and data envelopment methodologies.

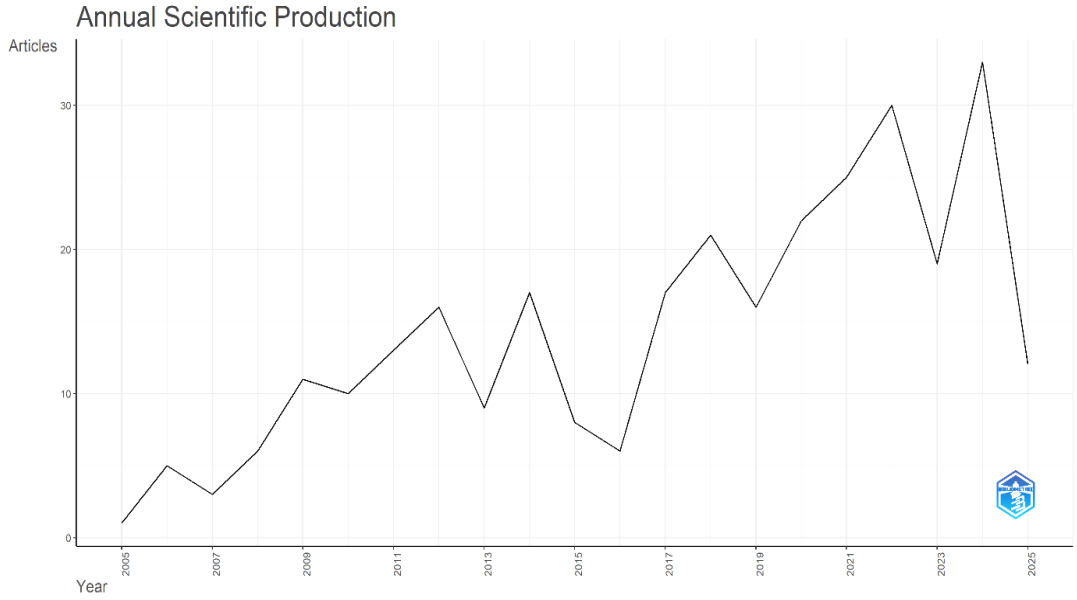


Fig.2.2. Number of papers published in Scopus relevant to efficiency analysis using DEA

Fig. 2.3 shows the network visualization map generated using VOSviewer depicts the co-occurrence relationships between key terms in the literature. The terms are grouped into thematic clusters, where red represents core concepts such as “data envelopment analysis,” “efficiency,” and “insurance.” These form the central focus of the research, showing strong interlinkages with terms like “insurance companies,” “technical efficiency,” and “DEA.” The green cluster includes terms such as “health insurance,” “human,” “productivity,” and “article,” indicating the relevance of human and healthcare dimensions in the field. Notably, “decision making,” displayed in blue, appears slightly isolated, suggesting a less integrated but emerging focus area. The term “China” is closely linked with “productivity” and “human,” highlighting its growing presence in related research. This map effectively illustrates the intellectual structure and major themes in the literature, reflecting the integration of performance measurement tools with insurance and human-centered research within the broader landscape of efficiency evaluation.

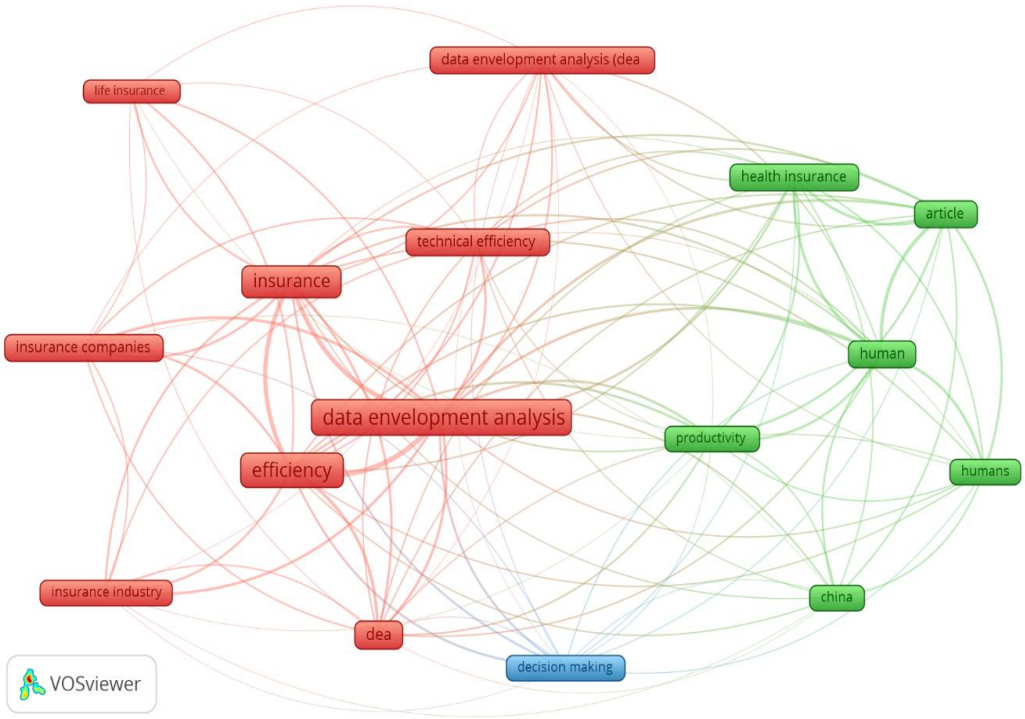


Fig.2.3. Co-occurrence network of keywords.

The three-field plot illustrates the interconnected relationship between keywords (DE), contributing countries (AU_CO), and thematic focus areas (AB_TM) in scholarly research. “Data Envelopment Analysis,” “efficiency,” and “insurance” emerge as key descriptors linked to various countries, with China, the USA, Iran, and India leading in publication volume. These nations contribute significantly to themes such as efficiency evaluation, insurance system analysis, and decision-support modeling. The visual representation highlights that studies from China and India are particularly aligned with efficiency and DEA-based methodologies, while the USA exhibits diverse associations across multiple themes. Additionally, technical terms like “model,” “study,” “analysis,” and “data” underline the methodological rigor common to this research domain. The map also emphasizes growing international collaboration, as seen in the dense links between countries and keywords. Overall, this visualization showcases the dominant research trajectories and the geographic spread of contributions, offering a concise view of the field’s intellectual structure and global reach.

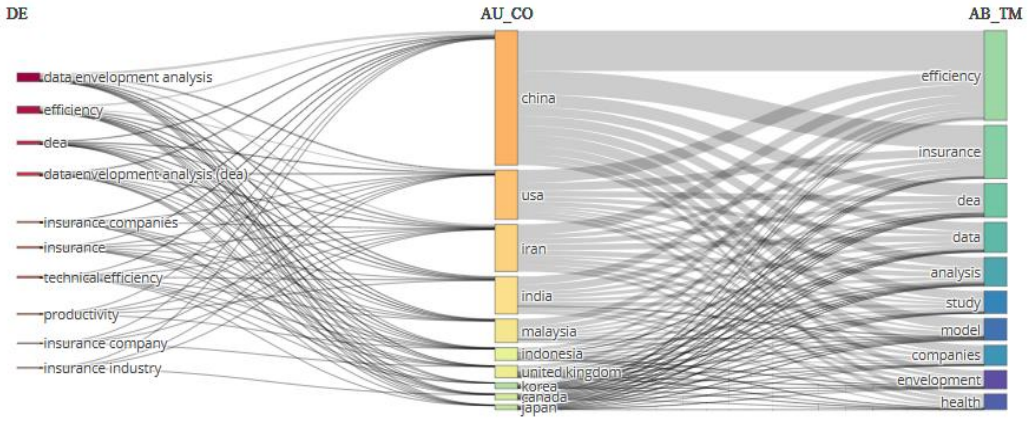


Fig.2.4. Three-field plot of keywords, countries and abstracts.

In Fig. 2.5, the word cloud provides a visual summary of the most prominent terms in the reviewed literature. “Data Envelopment Analysis,” “efficiency,” and “insurance” appear as dominant themes, indicating the central focus of recent studies. Keywords like “health insurance,” “human,” “decision making,” and “productivity” also feature strongly, suggesting interdisciplinary interest combining operational analysis with human-centric and policy-related concerns.


Fig.2.5. Word map of most frequent words.

The inclusion of terms such as “China,” “insurance industry,” and “article” reflects the geographical and academic context of the research. This visualization reinforces the importance of quantitative efficiency evaluation and highlights growing attention towards healthcare and human-related dimensions within the insurance sector’s performance assessment.

Fig. 2.6 shows the frequency of words over time and it can be concluded that efficiency analysis using DEA is having most appearance in research papers since 2013. The graph illustrates the cumulative frequency of selected keywords in academic publications between 2005 and 2025. It highlights a consistent upward trend in the use of terms such as “efficiency,” “decision making,” and “productivity.” Among these, “efficiency” shows the most prominent growth, particularly after 2017, suggesting increased academic interest in performance measurement. The terms “health insurance” and “insurance industry” also demonstrate a noticeable rise in recent years, indicating their growing relevance.

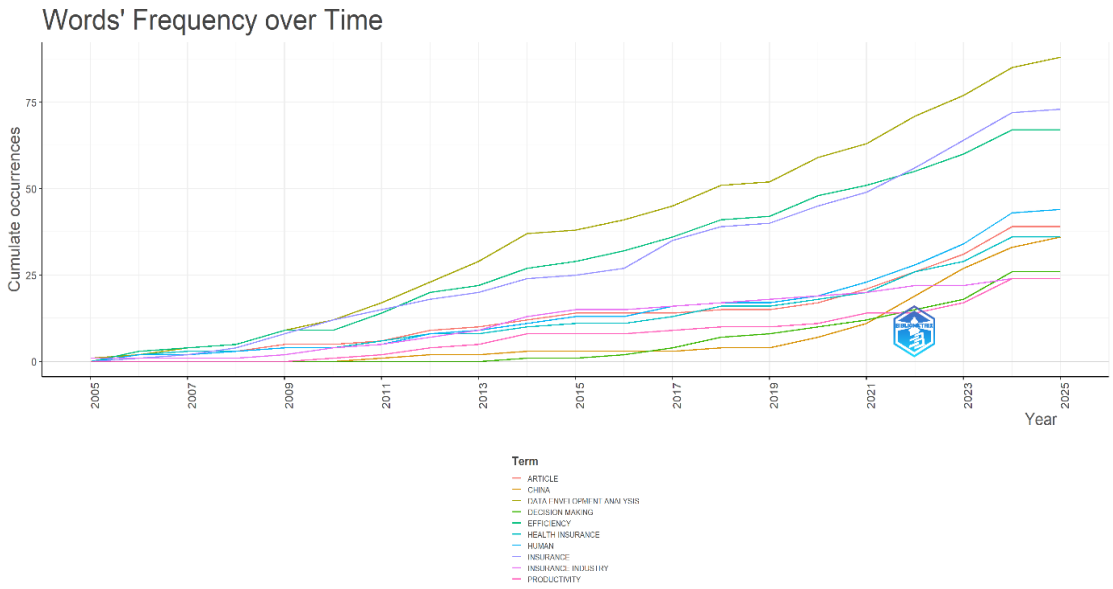


Fig.2.6. keyword frequency over time.

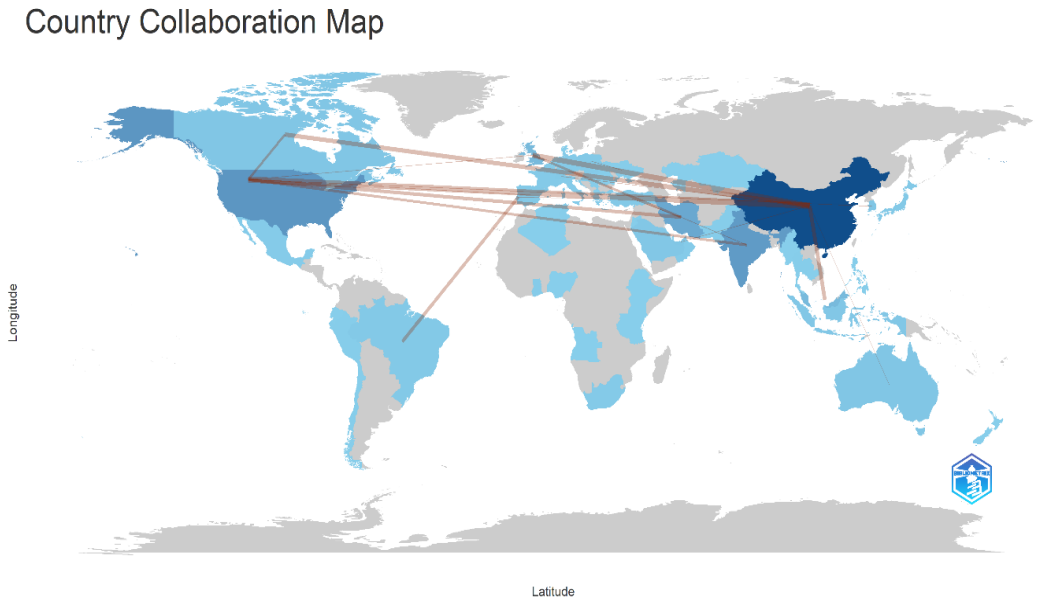


Fig.2.7. Country Collaboration Map

Overall, the graph reflects evolving research priorities, with a strong emphasis on decision-making processes, operational efficiency, and insurance-related themes across the observed time span.

Fig.2.7 shows world map which illustrates international research collaborations in the insurance domain, highlighting strong partnerships, with countries like China, India and USA emerging as leading contributors in cross-border scholarly engagement.

The Country Collaboration Map highlights the international research partnerships across different nations in the insurance and efficiency domain. Darker shades represent higher collaboration frequency, with China and India emerging as central contributors. These nations maintain strong academic ties with the United States, the United Kingdom, and several European countries, as indicated by the connecting lines. Such collaborations suggest a growing global interest in joint research, knowledge exchange, and interdisciplinary studies. The presence of multiple continents reflects the diverse contributions to this field, indicating a trend towards more inclusive and globally integrated scholarly efforts, particularly in data-driven insurance and efficiency research.

# CHAPTER 3

# DATABASE AND RESEARCH METHODOLOGY

## 3.1 Data Sources

The data used in this paper are from Annual report of  Insurance Regulatory and Development Authority of India (IRDAI)for the most recent five-year period, from 2019 to 2024. We consider all 11 of the reinsurance companies that were active in India during this time period, thus covering the full operational scope of the Indian reinsurance marketas shown in Table 1. The panel ensures thorough market coverage by including both domestic and foreign reinsurers that are registered in India.

Following practices common in financial sector efficiency analysis, the data available were limited to the disclosures mandated by the regulatory authority. Direct data on labor input were not accessible; hence, consistent with established proxy methodologies, commission and operating expenses were employed as proxies for operational effort and resource utilization. Equity was used as a financial input to reflect the capital strength of each reinsurer. On the output side, Net Earned Premium and Income on Investment were selected to represent core revenue-generating activities and financial returns.

## 3.2 Data Envelopment Analysis (DEA) Methodology

The effectiveness of general insurance businesses is assessed in this study using Data Envelopment Analysis (DEA), which treats each business as a Decision-Making Unit (DMU). Data is DEA is a non-parametric linear programming technique that

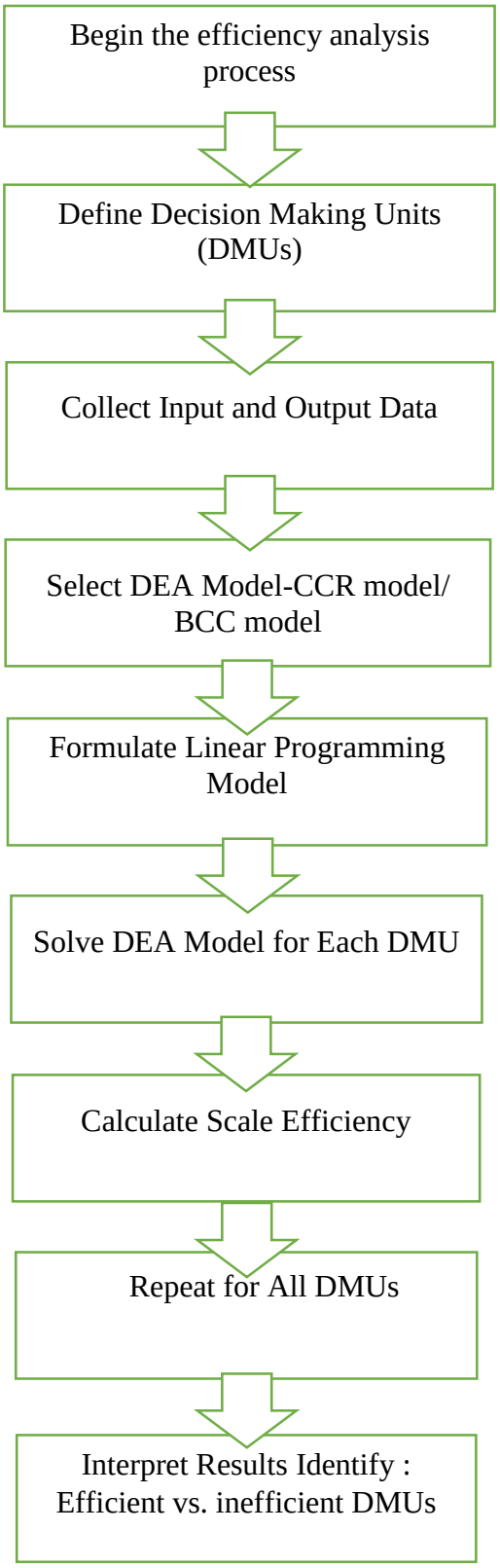


Fig. 3.1. DEA algorithm

determines relative efficiency by comparing DMUs with various inputs and outputs. There are two DEA models used: Constant Returns to Scale (CRS) are assumed by the CCR Model (Charnes et al., 1978). Variable Returns to Scale (VRS) are assumed by the BCC Model (Banker Rajiv D. et al., 1984). The DMU or DMUs with the highest inherent efficiency in transforming inputs $x_1,x_2,...,x_n$ into outputs $y_1$, $y_2,...,y_m$ were found in all DEA model versions, and all other DMUs were then ranked in relation to that most efficient DMU. The basic CRS Input Oriented model for $DMU_0$ is computed as follows:

$$maxh_0 = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}} \tag{3.1}$$

$$subject\ \ to: \ \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i-1}^{m} v_i x_{ij}} \leq 1 u_{r,} v_i \geq 0;$$

$$j = 1, \dots\dots\dots, n.$$

In order to optimize the efficiency score $h_o$ for $DMU_0$, the weights u and v were applied to outputs $y_n$ and $r_s$ inputs $x_{ij}$. Due to the limitation, no DMU's efficiency score can be higher than 1, an efficiency frontier that encompasses all data points in a convex hull was computed.This is transformed into a linear programming form for solvability:

$$maxh_0 \sum_{r=1}^{s} u_r y_{ro}; \tag{3.2}$$

Subject to:

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0;$$

$$\sum_{i=1}^{m} v_i\, x_{i0} = 1 \qquad u_{r,}\ v_{i0} \geq 0; \quad j = 1, \ldots \ldots, n$$

A decision-making unit's technical efficiency under constant returns to scale (CRS efficiency) is divided by its technical efficiency under variable returns to scale (VRS efficiency) to determine its scale efficiency. Using the comparison of the CCR and BCC models, **SE = 1** implies an optimal scale, and **SE < 1** indicates scale inefficiency. This methodology facilitates a robust efficiency analysis of Indian general insurers during 2020-24.

**TABLE 3.1 Lists of Potential Model Variables**

| | | | |
|---|---|---|---|
| Input 1 | Commission | Output 1 | Premiums earned (Net) |
| Input 2 | Operating Expenses | Output 2 | Income on Investment |
| Input 3 | Equity | Output 3 | Claims Incurred (Net) |
| Input 4 | AUM | Output 4 | Number of Network Hospitals |
| | | Output 5 | Grievance Resolution Ratio |
| | | Output 6 | CSR |

### 3.2.1 Description of Probable Input and output Variables

**TABLE 3.2 Description of Probable Input and output Variables**

| Type | Variable | Definition | References |
|---|---|---|---|
| **Input** | Commission | Commission includes fees paid to agents and brokers for acquiring policyholders. It is a core selling expense, often representing sales effort and market outreach. This variable is frequently used to analyze efficiency in labor-related costs in insurance operations. | (Summinder Kaur Bawa & Nidhi Bhaga, 2015) (Siddiqui, 2020) |
| **Input** | Operating Expenses | Operating expenses refer to administrative and managerial costs like salaries, rent, and utilities. These are necessary for daily functioning and are used in efficiency models to evaluate cost control and resource utilization among insurance firms. | (Diacon et al., 2000) (Siddiqui, 2020) |

| | | | |
|---|---|---|---|
| **Input** | Equity | Equity represents shareholders' capital used to support underwriting and investment activities. It contributes to financial stability and solvency. Insurers use equity as a fundamental input in analyzing capital efficiency and financial sustainability. | (Bawa & Ruchita, 2011) (Biener & Eling, 2012) |
| **Input** | AUM | AUM (Assets Under Management) indicates the value of financial assets managed by the insurer. It reflects the firm's investment scale and risk-bearing capacity, making it relevant in evaluating financial leverage and managerial efficiency. | (Yang, 2006) (Amir et al., 2013) |
| **Output** | Premiums Earned (Net) | Premiums earned (net) reflect actual income generated from policyholders, adjusted for reinsurance. This is a standard output used in DEA studies to represent the insurer's ability to generate revenue from core operations. | (Raj et al., 2023) |
| **Output** | Income on Investment | Investment income is the return earned from invested funds. It represents a major revenue source for insurers apart from underwriting and is used as an output to measure profitability and investment management performance. | (Yang, 2006) (Diacon et al., 2000) |
| **Output** | Claims Incurred (Net) | Claims incurred (net) represent the total value of claims paid or reserved, adjusted for reinsurance recoveries. It reflects the insurer's service delivery to policyholders and is used in DEA to assess service-based outputs. | (Diacon et al., 2000) (Yang, 2006) |
| **Output** | Number of Network Hospital | Network hospitals indicate service accessibility in health insurance, referring to the number of healthcare providers offering cashless treatment. This variable is used to evaluate the insurer's infrastructure and service network. | IRDAI Reports |
| **Output** | Grievance Resolution Ratio | Grievance resolution ratio measures the efficiency of customer complaint handling. It indicates service quality and | IRDAI Reports |

| | | | |
|---|---|---|---|
| | | responsiveness. Although less common in DEA, it's increasingly used in consumer-focused regulatory evaluations. | |
| **Output** | Claim Settlement Ratio | Claim settlement ratio shows the proportion of settled claims to total claims received. It reflects the insurer's reliability, operational efficiency, and customer trust, especially important in health and life insurance sectors. | IRDAI Reports |

### 3.2.2 Method of Selection of Input and Output

The potential input variables are commission, operating expenses, equity, and assets under management (AUM). The corresponding output variables are premium net, income on investment, claims incurred, number of network hospitals, grievance resolution ratio, and claim settlement ratio (CSR) shown in Table 3.1. Out of these inputs and outputs based on correlation and regression analysis best inputs and outputs are selected. Data is taken from annual reports from the Insurance Regulatory & Development Authority (IRDAI) for 2020-21,2021-22,2022-23 and 2023-24.

The correlation analysis is done on potential input variables for the years 2020–21 and 2021–22 shown in Table 3.2 and Table 3.3. The analysis reveals a consistently high correlation between commission, AUM (Assets Under Management), and operating expenses across both years—0.964 in 2020–21 and 0.939 in 2021–22. This strong association indicates that firms managing larger asset bases tend to incur higher operational costs, which is a logical outcome given the resource requirements for managing investments and operations at scale. Due to this high multicollinearity, including all three variables in the DEA model could distort efficiency estimation. Therefore, to avoid redundancy and ensure interpretability, only operating expenses are selected as an input variable. This choice is justified by the fact that operating expenses more directly represent the resource outflows or input costs associated with an insurer's functioning, aligning better with the DEA framework's focus on input-output transformation efficiency.

While other input equity are retained due to their distinct role representing financial strength. Finally “equity” and “operating expenses” are two input selected based on correlation analysis. This selection ensures a balanced and non-redundant input structure for the DEA model.

**TABLE 3.3 Correlation analysis of Potential Inputs for 2021**

| | Commission | Operating Expenses | Equity | AUM |
|---|---|---|---|---|
| Commission | 1 | | | |
| Operating Expenses | 0.849 | 1 | | |
| Equity | 0.443 | 0.540 | 1 | |
| AUM | 0.817 | 0.964 | 0.411 | 1 |

**TABLE 3.4 Correlation analysis of Potential Inputs for 2022**

| | Commission | Operating Expenses | Equity | AUM |
|---|---|---|---|---|
| Commission | 1 | | | |
| Operating Expenses | 0.674 | 1 | | |
| Equity | 0.348 | 0.448 | 1 | |
| AUM | 0.712 | 0.939 | 0.378 | 1 |

Source: Calculated by the author.

Similarly, correlation analysis is done on potential outputs as shown in Table 3.4. It can be interpreted that the correlation analysis reveals that premiums earned (net) are highly correlated with claims incurred (0.9946), indicating a strong operational linkage higher premium volumes are typically associated with higher claims settlement. However, while claims incurred is an important output in terms of customer satisfaction and service delivery, it is treated as a negative output from the insurer’s efficiency perspective, as higher claims represent higher outflows. Hence, for the DEA model, net premium earned was selected as the primary output variable, reflecting the insurer's revenue-generating capability while avoiding ambiguity in interpreting claims. Additionally, income on investment also shows a strong correlation with both premiums earned (0.9634) and claims incurred (0.9567). Despite this, it is retained as an output in the model because it captures a critical dimension of

strategic performance—how effectively the insurer utilizes the collected premiums to generate additional income. Investment income reflects financial management efficiency and long-term sustainability, making it a vital output for evaluating overall firm performance in the DEA framework decide what inputs and outputs should we consider for DEA.

**TABLE 3.5 Correlation analysis of Potential Outputs**

| | Net Premiums | Income on Investment | Claims Incurred | Network Hospitals | GRR | CSR |
|---|---|---|---|---|---|---|
| Net Premiums | 1 | | | | | |
| Income on Investment | 0.9634 | 1 | | | | |
| Claims Incurred | 0.9946 | 0.9567 | 1 | | | |
| Network Hospitals | 0.0968 | 0.0618 | 0.0848 | 1 | | |
| GRR | 0.0851 | 0.0470 | 0.0829 | -0.0825 | 1 | |
| CSR | -0.0080 | -0.1049 | -0.0146 | 0.1093 | 0.4230 | 1 |

Source: Calculated by the author.

Table 3.5 is regression analysis of each dependent variables(outputs) and independent variables(inputs) shown on next page.The regression analysis reveals that premiums earned (net) are highly predictable, with an $R^2$ of 0.987, and all predictors—commission, operating expenses, equity, and AUM—are statistically significant. This suggests that these financial factors strongly influence revenue generation in insurance firms. Similarly, income on investment shows a strong model fit ($R^2 = 0.978$), with equity and AUM emerging as key contributors, while commission and operating expenses have no significant impact, indicating that investment income is driven more by the capital base and asset volume. For claims incurred (net), the model also fits well ($R^2 = 0.974$), with commission and operating expenses being significant predictors, implying that claims are primarily influenced by operational scale rather than capital structure, also we have taken net premium over incurred claim earlier because of strong correlation between these two factor. In contrast, the number of network hospitals,

grievance resolution ratio, and CSR exhibit negative or near-zero $R^2$ values and lack statistical significance across all predictors. This indicates that these service-oriented and social performance indicators are not driven by financial or operational inputs used in the model and likely depend on other strategic or organizational variables.

In summary, while financial metrics effectively predict core business outcomes like premiums, claims, and investment income, they fail to explain non-financial indicators such as service coverage, grievance handling, and CSR. This is the reason why many earlier studies never considered these factors in DEA analysis in insurance sector, therefore we have taken only Net Premium and Income on Investment as outputs.

**TABLE 3.6 Regression Analysis's Findings with Dependent Variables**

| **Dependent Variable** | **R Square adjusted** | **Sig.** | **Statistics on the coefficient Predictors** | **Sig.** |
|---|---|---|---|---|
| Premiums earned (Net) | 0.987 | 0.000 | Commission | 0.000 |
| | | | Operating Expenses | 0.000 |
| | | | Equity | 0.004 |
| | | | AUM | 0.004 |
| Income on Investment | 0.978 | 0.000 | Commission | 0.505 |
| | | | Operating Expenses | 0.436 |
| | | | Equity | 0.008 |
| | | | AUM | 0.000 |
| Claims Incurred (Net) | 0.974 | 0.000 | Commission | 0.000 |
| | | | Operating Expenses | 0.003 |
| | | | Equity | 0.229 |
| | | | AUM | 0.243 |
| Number of Network Hospitals | -0.088 | 0.797 | Commission | 0.782 |
| | | | Operating Expenses | 0.668 |

| | | | | |
|---|---|---|---|---|
| | | | Equity | 0.568 |
| | | | AUM | 0.544 |
| Grievance Resolution Ratio | -0.095 | 0.829 | Commission | 0.583 |
| | | | Operating Expenses | 0.530 |
| | | | Equity | 0.986 |
| | | | AUM | 0.763 |
| CSR | -0.081 | 0.766 | Commission | 0.747 |
| | | | Operating Expenses | 0.205 |
| | | | Equity | 0.313 |
| | | | AUM | 0.232 |

Source: Calculated by the author.

## 3.3 Data Envelopment Analysis – Slack Based Measure

### 3.3.1 Method of Selection of input and output

Prior to finalizing these variables, an extensive **correlation analysis** and **regression analysis** were conducted among a broader set of probable inputs and outputs. These statistical assessments confirmed that commission and operating expenses, equity, net earned premium, and income on investment displayed the most appropriate relationships in terms of consistency, significance, and economic interpretability. Hence, they were selected as the optimal input-output combination for the purposes of this study.

It is important to acknowledge that the application of Data Envelopment Analysis (DEA) in this context faces certain methodological constraints. Specifically, with only 11 Decision Making Units (DMUs) — corresponding to the 11 reinsurers, this model has a practical limitation on the number of inputs and outputs that can be included. To maintain the discriminatory power and validity of the DEA results, it is necessary to restrict the total number of input and output variables. Therefore, the study is limited

to a maximum of four combined inputs and outputs, ensuring adherence to the standard DEA guideline which suggests that the number of DMUs should be at least three times the total number of input and output variables.Therefore two inputs commission and operating expenses are combined and used as a one input to reduce number of variables used in DEA analysis.

### 3.3.2 Data Envelopment Analysis – Slack Based Measure Methodology

The input-oriented SBM model under (Tone, 2001) proposed constant returns to scale (CRS) and variable returns to scale (VRS) was employed in this investigation. Let the DMU group beJ= $\{1,2, \ldots \ldots n\}$, each DMU having m inputs and s outputs. The vectors of inputs or outputs are being denoted for DMUjby $x_j = \left(x_{ij}, x_{2j}, \ldots, x_{mj}\right)^T$ and $y_j = \left(y_{ij,} y_{2j,} \ldots, y_{sj}\right)^T$, respectively. Input and output matrices X and Y are defined as below:

$$X = \left(x_{1,} x_{2,} \ldots, x_n\right) \in R^{m \times n} and Y = \left(y_{1,} y_{2,} \ldots, y_n\right) \in R^{s \times n}$$

All data are assumed to be positive. It means, x >0 ,y> 0. The production possibility set is defined in the set J as

$$P = \left\{ (x, y)/x \geq \sum_{j=i}^{n} \lambda_j \, x_{j,} 0 \leq y \leq \sum_{j=1}^{n} \lambda_j \, y_{j,} \lambda \geq 0 \right\}$$

Here, $\lambda = (\lambda_{1,} \lambda_{2,\ldots} \lambda_n)^T$ is called the intensity vector.

By adding slacks as indicated below as Eq.(3.3) and Eq.(3.4), the inequalities in the model above can be changed into equalities:

$$X = \sum_{j=1}^{n} \lambda_j \, x_j + s^- \tag{3.3}$$

$$\text{Y} = \sum_{j=1}^{n} \lambda_j \, Y_j - s^+ \tag{3.4}$$

Here, $s^- \geq 0, s^+ \geq 0$

Where $s^- = \left(s_{1,}^- s_2^-, \ldots, s_m^-\right)^T \in R^m and s^+ = (s_1^+, s_2^+, \ldots s_s^+)^T \in R^s$ are called input and output slacks.

Using the liner program below, the relative efficiency of $DMU_h = (x_h, y_h)$,is assessed.For h = 1,2,…n,this procedure is carried out n times, input-oriented SBM under CRS for $DMU_h = \left(x_{h,} y_h\right)$:

$$\theta_1^* = \min_{\lambda, s^-, s^+} 1 - \frac{1}{m} \sum_{i=1}^{m} \frac{s_i^-}{x_{ih}} \tag{3.5}$$

Subject to

$$x_{ih} = \sum_{j=1}^{n} x_{ij}\, \lambda_j + s_i^- (i = 1,2, \ldots, m)$$

$$y_{rh} = \sum_{j=1}^{n} y_{rj}\, \lambda_j - s_r^+ (r = 1,2, \ldots, s)$$

$$\lambda_j \geq 0 (\forall j), s_i^- \geq 0 (\forall i), s_r^+ \geq 0 (\forall r)$$

The SBM input efficiency is denoted by $\theta_1^*$. By adding the constraint e$\lambda$ = 1, where e is a row unit vector, the mentioned model can be transformed into the VRS model.$\theta_1^*$isunits invariant, meaning it doesn't depend on the units used to measure inputs and outputs. If $\theta_1^*$=1, then a$DMU_h = (x_h, y_h)$ is SBM input efficient. This indicates that all input slacks are zero, or$s^{-^*} = 0$. However, output slacks might not be zero.

An optimal solution $\left(\lambda^*, s^{-^*}, s^{+^*}\right)$is used to define a projection of a projection of $DMU_h = (x_h, y_h)$by

$$(\overline{x_h}, \overline{y_h}) = (\overline{x_h} - s^{-^*}, \overline{y_h} + s^{+^*})$$

The projected DMU is SBM input efficient.The definition of the reference set R of $DMU_h = (x_h, y_h)$ is

$$R=\{j/\lambda^* > 0, j \in J\}$$

Therefore, $(x_{h,} y_h)$ may be denoted as follows:

$$x_{ih} = \sum_{j \in R} x_{ij}\, \lambda_j^* + s^{-^*} \tag{3.6}$$

$$y_{rh} = \sum_{j \in R} y_{rj}\, \lambda_j^* - s^{+^*} \tag{3.7}$$

DMU in the reference set R of$(x_h, y_h)$are SBM input efficient.

## 3.4 The Malmquist Input-Based Productivity Index

The performance of a decision-making unit (DMU) is evaluated over two distinct time periods using the Malmquist model. It illustrates how much the DMU has done to increase its efficiency and how the efficiency frontier has changed throughout that period. According to (Färe Rolf et al., 1994), the index can be broken down into a technical change and efficiency change measure between period (t + 1) (reference technology period) and period (t –1) (base technology period). Under the assumption of VRS, the input-oriented Malmquist input-based productivity index (MPI) is given in Eq. (3.8) as

$$(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{d^t(x^{t+1}, y^{t+1})}{d^t(x^t, y^t)} \times \frac{d^{t+1}(x^{t+1},\ y^{t+1})}{d^{t+1}(x^t,\ y^t)}\right]^{1/2} \tag{3.8}$$

Where $x^t\ and\ y^t$ are input and output vectors, respectively, and $d^t(x^t, y^t)$ refers to the distance between period t and t+1.

This study uses the Slacks-Based Measure (SBM) approach of Data Envelopment Analysis (DEA) to evaluate technical efficiency. Since technical efficiency is the only focus, the analysis is conducted using the SBM framework's Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) assumptions. To find departures from the ideal operational size, Scale Efficiency is also calculated for every company during the research period.The use of the SBM model allows for a more accurate evaluation of inefficiencies by directly accounting for input excesses and output shortfalls (slacks), providing a detailed and robust analysis of the performance of Indian reinsurance companies.

**Technical Efficiency**: In SBM-DEA, technical efficiency shows how well a company can get the most output using the least input, along with taking into account any extra resources used or missed opportunities in results.It captures both the managerial effectiveness and the firm's scale of operations. A firm is considered technically efficient under SBM-DEA if it lies on the best-practice frontier with no unutilized inputs or unrealized outputs.

**Pure Technical Efficiency:** Under SBM-DEA isolates managerial performance by employing a Variable Returns to Scale (VRS) assumption while still explicitly incorporating input and output slacks into the efficiency measurement. It eliminates the scale effect, thereby highlighting inefficiencies that arise solely due to poor resource utilization, operational mismanagement, or suboptimal productivity, without the distortions introduced by firm size.

**Scale Efficiency** in the SBM-DEA framework measures whether a firm's size is optimal for achieving efficiency. Assuming that internal operations are otherwise efficient (i.e., no slacks apart from scale effects), scale efficiency identifies inefficiencies attributable purely to operating at a non-optimal scale. A firm may experience scale inefficiency if it operates either below or above the most productive size, even if managerial resource utilization is otherwise optimal.

# CHAPTER 4

# RESULT AND DISCUSSION

## 4.1 General Insurance Companies

*DEA Analysis under CRS*

The DEA analysis using the CCR model evaluated the efficiency of various insurance companies over four financial years (2020-2024) shown in Table 4.1. Among the assessed insurers, The New India Assurance Co. Ltd. consistently maintained an optimal efficiency score of 1, indicating best practice performance throughout the study period. Other public insurers, including National , The Oriental , and United India , showed moderate efficiency with average scores of approximately 0.576, 0.620, and 0.537 respectively, reflecting scope for significant operational improvements. Private entities such as Acko General Insurance exhibited notably lower efficiency, averaging just 0.152. These findings suggest private insurers, in particular, require focused interventions in resource management to improve their efficiency. Public insurers also must strive towards sustained efficiency to enhance competitive positioning. Overall, the analysis highlights substantial efficiency gaps within the sector, recommending targeted managerial strategies to address these deficiencies.

**TABLE 4.1 Technical Efficiency Estimates Under CRS**

| Insurer | 2020-21 | 2021-22 | 2022-23 | 2023-24 | Mean |
|---|---|---|---|---|---|
| National | .541 | .710 | .446 | .606 | .576 |
| The New India Assurance | 1 | 1 | 1 | 1 | 1 |
| The Oriental | .598 | .591 | .517 | .774 | .620 |
| United India | .579 | .548 | .429 | .591 | .537 |
| Acko Gen. | .133 | .132 | .149 | .196 | .152 |
| Bajaj Allianz Gen. | 1 | 1 | 1 | 1 | 1 |
| CholamandalamMS Gen. | .641 | .600 | .654 | .901 | .699 |
| Future Gen.i India | .411 | .376 | .386 | .738 | .478 |
| Go Digit Gen. | .361 | .330 | .360 | .873 | .481 |
| HDFC ERGO Gen. | .542 | .548 | .577 | .780 | .612 |
| ICICI Lombard Gen. | .842 | .726 | .777 | .978 | .831 |
| IFFCO Tokio Gen. | 1 | .858 | .870 | 1 | .932 |
| Kotak Mahindra Gen. | .383 | .294 | .259 | .378 | .328 |
| Liberty Gen. | .409 | .399 | .431 | .744 | .496 |
| Magma HDI Gen. | .397 | .371 | .337 | .887 | .498 |
| Navi Gen. | .177 | .139 | .641 | .430 | .347 |
| Raheja QBE Gen. | .268 | .294 | .315 | .444 | .330 |
| Reliance Gen. | .656 | .639 | .682 | .818 | .699 |
| Royal Sundaram Gen. | .712 | .660 | .599 | .932 | .726 |
| SBI Gen. | .675 | .548 | .656 | .894 | .693 |
| Shriram Gen. | 1 | 1 | 1 | 1 | 1 |
| Tata AIG Gen. | .469 | .485 | .542 | .713 | .552 |
| Universal Sompo Gen. | .813 | .676 | .557 | .771 | .704 |
| Stand Alone Insurance | | | | | |
| Aditya Birla | .209 | .221 | .300 | .447 | .294 |
| Care | .383 | .326 | .423 | .601 | .433 |
| ManipalCigna | .306 | .288 | .307 | .472 | .343 |
| Niva Bupa | .335 | .284 | .321 | .502 | .360 |
| Star & Allied | .527 | .741 | .780 | .756 | .701 |
| **Average Efficiency Yearwise** | .549 | .528 | .547 | .722 | **.587** |

Source: Calculated by the author.

Figure 4.1 presents the efficiency levels of several Indian general insurance companies for the financial year 2023–24, assessed using the Data Envelopment Analysis (DEA) constant return to scale model. Insurers with scores near 1.0 are considered efficient, while others indicate varying degrees of underperformance.


Fig 4.1 Efficiency Analysis of Indian General Insurance Companies Using DEA CCR Model (2023–2024)

*DEA Analysis under VRS*

The **BCC** model, which allows for variable returns to scale, offered a more nuanced view of efficiency shown in Table 4.2. The New India Assurance Co. Ltd. again stood out with perfect scores across all four years, indicating that it operates efficiently even under variable returns to scale. However, other insurers, such as United India and National , demonstrated slightly lower efficiency than in the CCR model, with scores ranging from **0.536** to **0.743** on average. These values reflect inefficiencies tied to scaling, where these companies could perform better if their operations were better aligned to variable returns to scale. Acko General Insurance Ltd. again showed the lowest efficiency, with scores averaging **0.329**, suggesting that its scale management and operational optimization need substantial improvements.

**TABLE 4.2 Technical Efficiency Estimates Under VRS**

| Insurer | 2020-21 | 2021-22 | 2022-23 | 2023-24 | Mean |
|---|---|---|---|---|---|
| National | .886 | .817 | .480 | .790 | .743 |
| The New India Assurance | 1 | 1 | 1 | 1 | 1 |
| The Oriental | .954 | .675 | .593 | 1 | .805 |
| United India | .894 | .671 | .474 | .736 | .694 |
| Acko Gen. | .518 | .366 | .217 | .216 | .329 |
| Bajaj Allianz Gen. | 1 | 1 | 1 | 1 | 1 |
| CholamandalamMS Gen. | .694 | .694 | .751 | .903 | .761 |
| Future Gen.i India | .453 | .461 | .445 | .756 | .529 |
| Go Digit Gen. | .415 | .398 | .404 | .876 | .523 |
| HDFC ERGO Gen. | .607 | .565 | .588 | .845 | .652 |
| ICICI Lombard Gen. | .954 | .769 | .831 | 1 | .889 |
| IFFCO Tokio Gen. | 1 | 1 | 1 | 1 | 1 |
| Kotak Mahindra Gen. | .862 | .742 | .547 | .472 | .656 |
| Liberty Gen. | .518 | .594 | .459 | .789 | .590 |
| Magma HDI Gen. | 1 | 1 | .975 | .997 | .993 |
| Navi Gen. | 1 | 1 | 1 | 1 | 1 |
| Raheja QBE Gen. | 1 | 1 | 1 | 1 | 1 |
| Reliance Gen. | .700 | .725 | .769 | .819 | .753 |
| Royal Sundaram Gen. | .775 | .788 | .721 | .953 | .809 |
| SBI Gen. | .842 | .852 | .959 | .997 | .913 |
| Shriram Gen. | 1 | 1 | 1 | 1 | 1 |
| Tata AIG Gen. | .541 | .490 | .543 | .822 | .599 |
| Universal Sompo Gen. | .987 | .944 | .897 | .865 | .923 |
| Stand Alone Insurance | | | | | |
| Aditya Birla | .519 | .551 | .602 | .510 | .546 |
| Care | .452 | .421 | .483 | .605 | .490 |
| ManipalCigna | .500 | .560 | .371 | .511 | .485 |
| Niva Bupa | .436 | .406 | .345 | .511 | .424 |
| Star & Allied | .530 | .788 | .831 | .770 | .730 |
| **Average Efficiency Yearwise** | .751 | .724 | .689 | .812 | .744 |

Source: Calculated by the author.

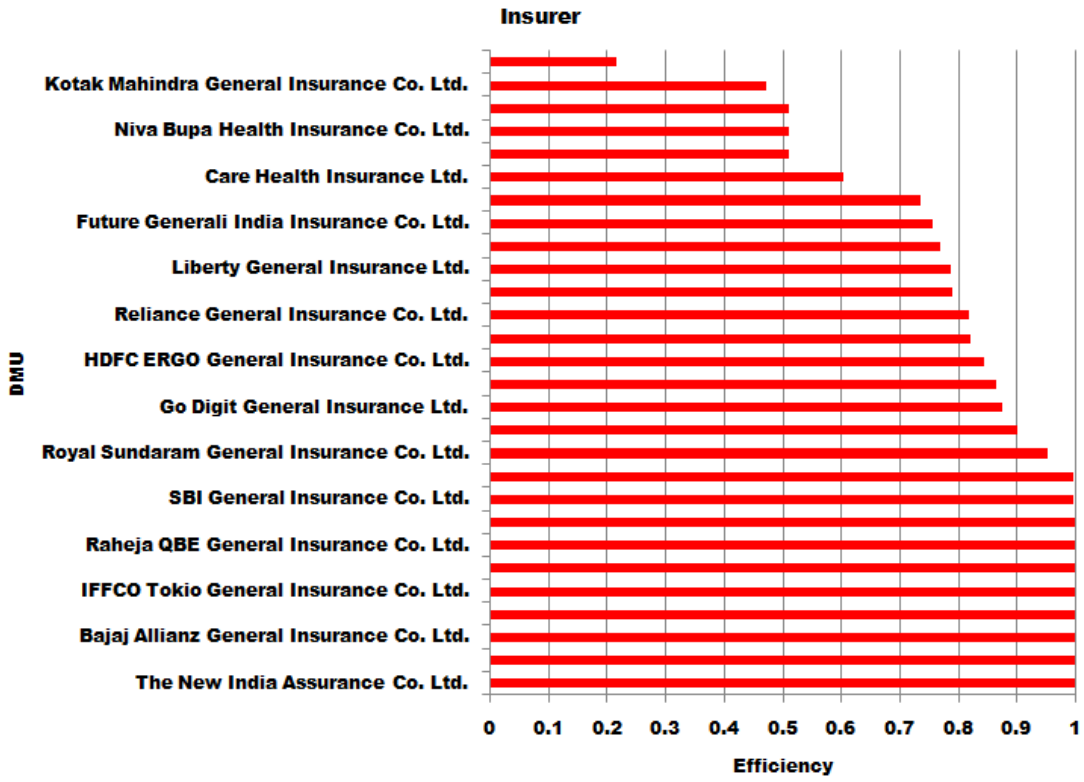


Fig 4.2 Efficiency Analysis of Indian General Insurance Companies Using DEA BCC Model (2023–2024)

Figure 4.2 illustrates the DEA-based efficiency results for Indian general insurance companies during the 2023–24 period. Companies achieving efficiency scores near 1.0 are regarded as operating optimally in terms of input-output utilization. In contrast, firms with lower scores suggest performance gaps, indicating scope for improving how resources are managed compared to industry benchmarks.

The **CRS model** results reflect overall technical efficiency,assuming all insurers are functioning at their ideal scale. The average CRS efficiency acrossthe four years is **0.587**, indicating that, on average, insurers are utilizing only about **58.6%** of their input resources effectively. This underscores a significant degree of overall inefficiency at the current scale of operations, especially for smaller or newer firms.Under the **VRS model**, which isolates pure technical efficiency by accounting for scale effects,the average efficiency improves significantly to **0.744**. This indicates that when scale inefficiencies are excluded, firms are managing their operations more effectively,

suggesting that the observed inefficiencies under CRS are largely attributable to suboptimal scale rather than internal operational issues.

**TABLE 4.3 Scale Efficiency**

| Insurer | 2020-21 | 2021-22 | 2022-23 | 2023-24 | Mean |
|---|---|---|---|---|---|
| National | 0.610 | 0.869 | 0.931 | 0.767 | 0.794 |
| The New India Assurance | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| The Oriental | 0.627 | 0.876 | 0.873 | 0.774 | 0.787 |
| United India | 0.648 | 0.817 | 0.905 | 0.803 | 0.793 |
| Acko Gen. | 0.257 | 0.361 | 0.686 | 0.905 | 0.553 |
| Bajaj Allianz Gen. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| CholamandalamMS Gen. | 0.923 | 0.865 | 0.870 | 0.998 | 0.914 |
| Future Gen.i India | 0.907 | 0.817 | 0.867 | 0.976 | 0.892 |
| Go Digit Gen. | 0.870 | 0.829 | 0.892 | 0.996 | 0.897 |
| HDFC ERGO Gen. | 0.893 | 0.969 | 0.981 | 0.923 | 0.941 |
| ICICI Lombard Gen. | 0.882 | 0.944 | 0.936 | 0.978 | 0.935 |
| IFFCO Tokio Gen. | 1.000 | 0.858 | 0.870 | 1.000 | 0.932 |
| Kotak Mahindra Gen. | 0.444 | 0.396 | 0.473 | 0.800 | 0.528 |
| Liberty Gen. | 0.790 | 0.672 | 0.939 | 0.944 | 0.836 |
| Magma HDI Gen. | 0.397 | 0.371 | 0.345 | 0.890 | 0.501 |
| Navi Gen. | 0.177 | 0.139 | 0.641 | 0.430 | 0.347 |
| Raheja QBE Gen. | 0.268 | 0.294 | 0.315 | 0.444 | 0.330 |
| Reliance Gen. | 0.937 | 0.881 | 0.887 | 0.999 | 0.926 |
| Royal Sundaram Gen. | 0.918 | 0.838 | 0.830 | 0.978 | 0.891 |
| SBI Gen. | 0.802 | 0.643 | 0.684 | 0.897 | 0.756 |
| Shriram Gen. | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Tata AIG Gen. | 0.866 | 0.990 | 0.999 | 0.867 | 0.931 |
| Universal Sompo Gen. | 0.824 | 0.716 | 0.620 | 0.891 | 0.763 |
| Stand Alone Insurance | | | | | |
| Stand Alone Insurance | 0.403 | 0.402 | 0.499 | 0.876 | 0.545 |
| Aditya Birla | 0.848 | 0.774 | 0.876 | 0.993 | 0.873 |
| Care | 0.613 | 0.515 | 0.826 | 0.922 | 0.719 |
| ManipalCigna | 0.767 | 0.700 | 0.930 | 0.982 | 0.845 |
| Niva Bupa | 0.995 | 0.940 | 0.938 | 0.982 | 0.964 |
| **Average Efficiency** | 0.738 | 0.731 | 0.808 | 0.893 | **0.793** |
| **Scale efficient firms** | **4.000** | **3.000** | **3.000** | **4.000** | **3.000** |

Source: Calculated by the author.

With values varying greatly throughout insurers, the Scale Efficiency (SE), which is computed as the ratio of CRS to VRS, has an average of 0.793 shown in Table

4.3. This indicates that a large number of businesses are not functioning at their most efficient scale. Some firms such as The New India Assurance, Bajaj Allianz, Shriram General, and IFFCO Tokio General consistently achieved perfect efficiency scores ( 1) under both CRS and VRS models, highlighting their optimal size and efficient operations. In contrast, several emerging players such as Acko General, Navi General, and Raheja QBE displayed lower CRS scores but achieved full VRS scores, indicating effective operational practices despite being below optimal scale.Notably, efficiency levels show improvement over time, particularly in 2023–24, where the mean scores for CRS and VRS rose to **0.722** and **0.812** respectively. This suggests post-pandemic recovery and adaptive improvements in cost management and process optimization.

## 4.2 Reinsurance Companies

*DEA Analysis under CRS*

The technical efficiency scores for the eleven Indian reinsurers over the period 2019–2024 were estimated using the SBM-DEA under the Constant Returns to Scale (CCR) assumption in an input-oriented model. The results are summarized in Table 4.4. The analysis reveals that GIC Re consistently achieved a perfect efficiency score of 1 across all five years, indicating that it operated on the best-practice frontier throughout the study period without any input excesses or output shortfalls. RGA also demonstrated near-perfect efficiency, with an average score of 0.996, achieving a full efficiency score of 1 in four of the five years.Similarly, AXA France Vie maintained high performance, achieving an average technical efficiency score of 0.929, showing full efficiency in the last three years of the period. Other reinsurers, however, showed significant variability in their efficiency levels. For instance, Gen Re exhibited high efficiency with an average score of 0.897 but faced a notable decline in 2022–23, where the score dropped to 0.484. Hannover Re displayed considerable fluctuations, achieving full efficiency in 2020–21 and 2023–24 but falling as low as 0.209 in 2022–23. In contrast, Lloyd’s of India consistently remained among the least efficient

reinsurers, recording very low scores across all years, with an average technical efficiency of just 0.382. SCOR SE and Swiss Re also registered below-average performance, with average efficiency scores of 0.458 and 0.530 respectively, reflecting persistent operational inefficiencies or resource underutilization.

**TABLE 4.4 Estimates of Technical Efficiency of Reinsurers under SBM-DEA CCR (CRS)**

| Reinsurer | 2019-20 | 2020-21 | 2021-22 | 2022-23 | 2023-24 | Average |
|---|---|---|---|---|---|---|
| GIC | 1 | 1 | 1 | 1 | 1 | 1 |
| Allianz Global | .604 | .217 | 1 | .241 | .696 | .552 |
| AXAFranceVie | .646 | 1 | 1 | 1 | 1 | .929 |
| GenRe | 1 | 1 | 1 | .484 | 1 | .897 |
| HannoverRe | .229 | 1 | .967 | .209 | 1 | .681 |
| Lloyd's of India- | 1 | .188 | .217 | .226 | .279 | .382 |
| Munich Re | .252 | .415 | .348 | .433 | 1 | .490 |
| RGA | .982 | 1 | 1 | 1 | 1 | .996 |
| SCOR-SE | .512 | .453 | .317 | .306 | .704 | .458 |
| Swiss-Re | .295 | .748 | .496 | .359 | .751 | .530 |
| XL-SE | .743 | .617 | .379 | .952 | 1 | .738 |
| **Average** | **.660** | **.694** | **.702** | **.565** | **.857** | **.696** |

Source: Based on the author's computation

The average technical efficiency for all reinsurers and years is 0.696, meaning that the reinsurers generally operated at about 69.6% of the efficiency frontier.This suggests substantial room for operational improvements and resource optimization among the majority of firms. Year-wise, technical efficiency was the highest in 2023–24 (0.857) and lowest in 2022–23 (0.565), pointing toward recent positive developments or corrective measures taken by reinsurers in the later period.The variation in scores highlights the differing capacities of reinsurers to manage their inputs effectively and maximize outputs.

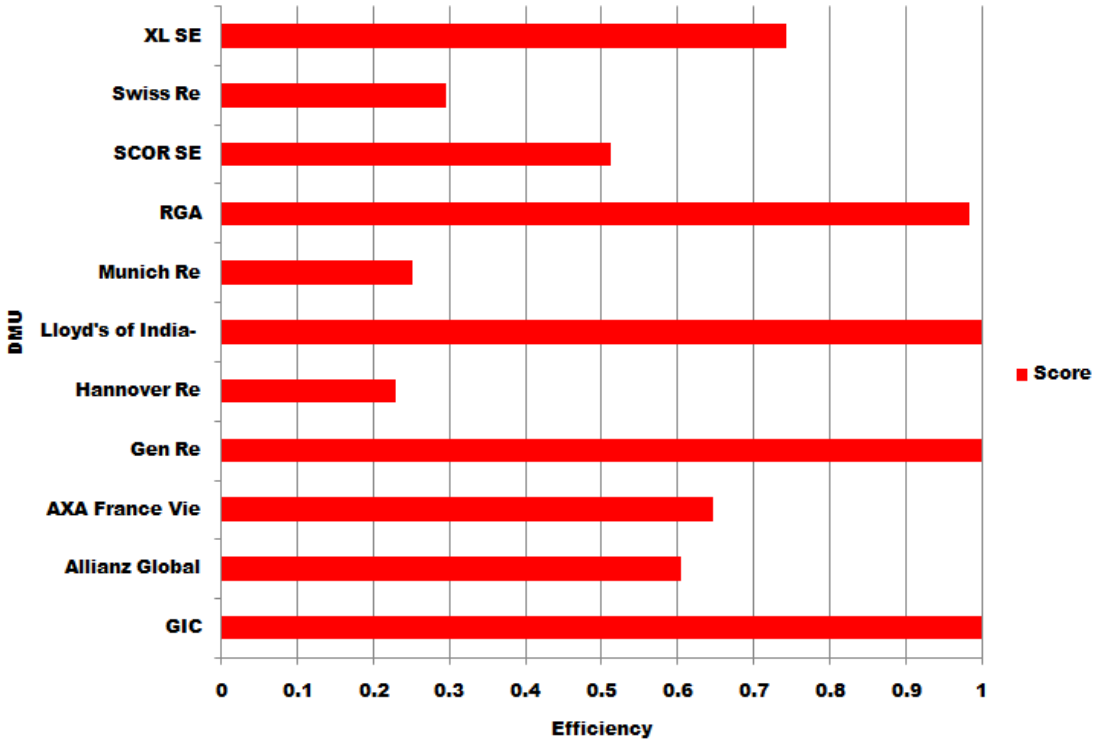


Fig.4.3 Efficiency Scores of Reinsurance Firms CCR Model (2019–2020)

Firms with lower scores may need to revisit their operational strategies, optimize internal processes, and better align resources with performance outputs to move closer to the efficiency frontier.A comparative analysis between domestic and foreign reinsurers reveals that the Indian reinsurer, GIC Re, consistently achieved full technical efficiency across all five years, demonstrating superior operational management. Among foreign reinsurers, while entities like RGA and AXA France Vie performed commendably with high average efficiency scores (0.996 and 0.929 respectively), several others, including Lloyd's of India, SCOR SE, and Swiss Re, exhibited relatively lower efficiency levels. This suggests that while certain foreign reinsurers have successfully adapted to the Indian market dynamics, others continue to face challenges in optimizing their operations within the local regulatory and competitive environment.

Figure 4.3 illustrates the efficiency results of selected reinsurers under the DEA SBM CCR framework for 2019-20. Scores above 1 are not shown as standard efficiency limits were applied. Firms nearing a score of 1 indicate stronger performance, while

lower scores suggest scope for efficiency improvement relative to peers.

*DEA Analysis under VRS*

The results as shown in Table 4.5 tell the Pure Technical Efficiency (PTE) of the reinsurers during the period 2019–2024. It shows that GIC Re, AXA France Vie, RGA, and Lloyd's of India performed at full efficiency every year for five years and they have managed their resources very well, without wasting anything or falling short, even when the size of the company was not a factor. These firms operated on the best-practice frontier throughout the study period, highlighting their strong internal operations and adaptability to market dynamics.

**TABLE 4.5: Estimates of Technical Efficiency of Reinsurers under SBM-DEA BCC(VRS)**

| **Reinsurer** | **2019-20** | **2020-21** | **2021-22** | **2022-23** | **2023-24** | **Average** |
|---|---|---|---|---|---|---|
| GIC | 1 | 1 | 1 | 1 | 1 | 1 |
| Allianz Global | .626 | .633 | 1 | .612 | .700 | .714 |
| AXAFranceVie | 1 | 1 | 1 | 1 | 1 | 1 |
| GenRe | 1 | 1 | 1 | .560 | 1 | .912 |
| HannoverRe | .453 | 1 | 1 | .289 | 1 | .748 |
| Lloyd's of India | 1 | 1 | 1 | 1 | 1 | 1 |
| Munich Re | .334 | .444 | .367 | .453 | 1 | .520 |
| RGA | 1 | 1 | 1 | 1 | 1 | 1 |
| SCOR-SE | .530 | .527 | .392 | .411 | .725 | .517 |
| Swiss-Re | .395 | 1 | .500 | .370 | .756 | .604 |
| XL-SE | .812 | 1 | .720 | 1 | 1 | .906 |
| **Average** | **.741** | **.873** | **.816** | **.700** | **.925** | **.811** |

Source: Based on the author's computation

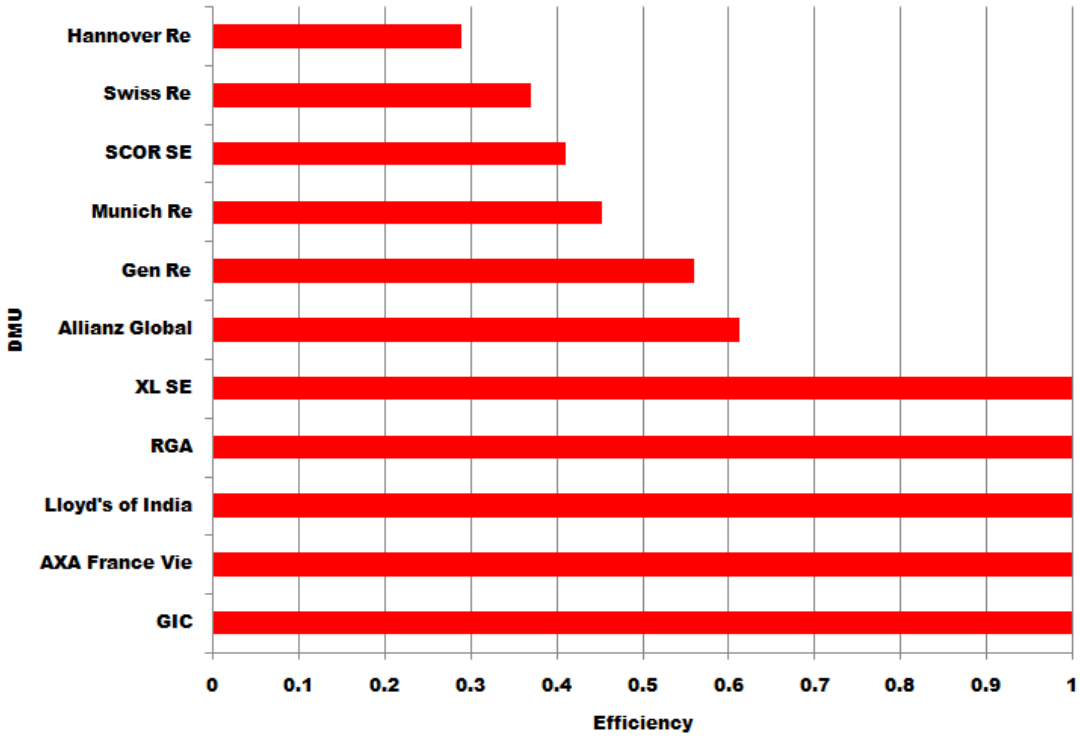


Fig.4.4 Efficiency Scores of Reinsurance Firms BCC Model (2022–2023)

Figure 4.4 presents the efficiency levels of selected Indian reinsurers evaluated using the DEA SBM BCC model. Firms scoring 1.0 are considered efficient, while others show varying degrees of inefficiency, offering a benchmark for comparative performance within the industry.

Among the foreign reinsurers, Gen Re demonstrated high performance, with an average PTE score of 0.912, despite a noticeable dip to 0.560 in 2022–23. XL SE also maintained strong performance with an average efficiency of 0.906, achieving full efficiency in multiple years. With an average score of 0.714 under VRS, Allianz Global demonstrated significant improvement over the CCR results, indicating improved internal operational management in spite of scale inefficiencies previously noted. The performance of other reinsurers, such as Swiss Re and Hannover Re, was inconsistent. Hannover Re's overall average score was 0.748, with full efficiency in 2020–21, 2021–22, and 2023–24, but lower efficiency in 2019–20 and 2022–23. Even after controlling for scale effects, Swiss Re showed only a slight improvement,

achieving an average PTE of 0.604. This suggests that internal inefficiencies still exist.With lower average PTE scores of 0.517 and 0.520, respectively, SCOR SE and Munich Re demonstrated persistent difficulties with operational management and internal resource utilization throughout the study period.Across all reinsurers and years, the average Pure Technical Efficiency was 0.811, significantly higher than the average technical efficiency under the CRS assumption (0.696). This improvement suggests that a considerable portion of the inefficiency observed earlier can be attributed to scale-related issues rather than managerial shortcomings. Year-wise, the highest efficiency was observed in 2023–24 (average 0.925) and the lowest in 2022–23 (average 0.700), indicating an upward trend towards the end of the period.The findings imply that when scale effects are removed, several reinsurers demonstrate strong managerial capabilities. However, the performance gaps among the firms highlight that specific reinsurers still need to enhance internal operational strategies to fully capitalize on their resource potentials.

*Scale Efficiency Analysis*

The scale efficiencies of eleven Indian reinsurers were calculated under the input-oriented SBM-DEA model, and the results are presented in Table 4.6. Scale efficiency reflects the extent to which a firm is operating at its most productive size, independent of internal managerial performance. The analysis reveals that GIC Re consistently achieved a perfect scale efficiency score of 1 across all five years, indicating that it operated at the optimal scale without any scale-related inefficiency throughout the study period. RGA and Gen Re also demonstrated near-perfect scale efficiency, with average scores of 0.996 and 0.973 respectively, reinforcing their strong positioning both operationally and size-wise within the market. AXA France Vie, Munich Re, and SCOR SE achieved high average scale efficiency scores of 0.929, 0.919, and 0.870 respectively. Notably, AXA France Vie achieved a perfect score in four of the five years after an initial lower efficiency (0.646) in 2019–20, indicating rapid scale optimization in subsequent periods.Conversely, Lloyd’s of India recorded the lowest average scale efficiency of 0.382, with particularly low scores across all years, suggesting significant scale inefficiencies. Despite achieving Pure Technical

Efficiency under VRS assumptions, its poor scale efficiency underscores that Lloyd's operational size has remained suboptimal, limiting its overall effectiveness.Allianz Global displayed considerable fluctuation in scale efficiency, ranging from 0.343 in 2020–21 to nearly full efficiency (0.994) in 2023–24, with an overall average of 0.739. Swiss Re and XL SE also demonstrated moderate scale efficiency levels, with averages of 0.890 and 0.802 respectively. Year-wise, the overall average scale efficiency increased from 0.790 in 2020–21 to 0.931 in 2023–24, indicating a gradual and positive trend towards optimal scale management among Indian reinsurers over the five-year period.

**TABLE 4.6 Estimates of Scale Efficiency of Reinsurers under SBM-DEA**

| **Reinsurer** | **2019-20** | **2020-21** | **2021-22** | **2022-23** | **2023-24** | **Average** |
|---|---|---|---|---|---|---|
| GIC | 1 | 1 | 1 | 1 | 1 | 1 |
| Allianz Global | .965 | .343 | 1 | .394 | .994 | .739 |
| AXAFranceVie | .646 | 1 | 1 | 1 | 1 | .929 |
| GenRe | 1 | 1 | 1 | .864 | 1 | .973 |
| HannoverRe | .505 | 1 | .967 | .724 | 1 | .839 |
| Lloyd's of India- | 1 | .188 | .217 | .226 | .279 | .382 |
| Munich Re | .755 | .933 | .948 | .957 | 1 | .919 |
| RGA | .982 | 1 | 1 | 1 | 1 | .996 |
| SCOR-SE | .966 | .858 | .809 | .744 | .971 | .870 |
| Swiss-Re | .747 | .748 | .993 | .970 | .993 | .890 |
| XL-SE | .915 | .617 | .526 | .952 | 1 | .802 |
| **Average** | **.862** | **.790** | **.860** | **.803** | **.931** | **.849** |

Source: Based on the author's computation

The industry-wide improvement suggests that firms have increasingly optimized their operational scales, possibly driven by regulatory reforms, market competition, and strategic restructuring.Companies like GIC Re and RGA kept getting high scores in all models, showing they have strong management and the right company size to work efficiently. On the other hand, firms like Lloyd's of India manage their operations well

but still struggle because their size isn’t ideal. This means it  is not poor management that's the problem but the company size that is it is either too big or too small to run at full efficiency.

*Malmquist Productivity Index Analysis*

Using a method that focuses on reducing inputs while allowing for changes in scale, the Malmquist Productivity Index (MPI) was used to measure how the productivity of Indian reinsurance companies changed over time from 2019 to 2024 as presented in Table 4.7.

**TABLE 4.7  Malmquist Index Summary of Firm(Reinsurers) Means 2019-2024**

| **Reinsurer** | **Effch** | **Techch** | **TFPch** |
|---|---|---|---|
| GIC | .988 | 1.513 | 1.495 |
| Allianz Global | .964 | 1.335 | 1.287 |
| AXAFranceVie | 1.465 | 1.862 | 2.728 |
| GenRe | .743 | .644 | .479 |
| HannoverRe | .914 | 1.286 | 1.176 |
| Lloyd's of India- | 1 | 1.074 | 1.074 |
| Munich Re | .799 | 1.125 | .899 |
| RGA | 1.062 | 1.024 | 1.087 |
| SCOR-SE | .998 | 1.021 | 1.019 |
| Swiss-Re | .812 | 1.069 | .867 |
| XL-SE | 1 | 1.114 | 1.114 |
| **Average** | **.962** | **1.151** | **1.107** |

Source: Based on the author's computation

The Malmquist Index helps show whether companies are getting better because they are managing things more efficiently or because there have been improvements in technology across the whole industry. During the study period, the average productivity of the industry grew by about 10.7% each year, as shown by a Total Factor Productivity Change (TFPch) score of 1.107.A technological change (Techch) of 1.151, or 15.1% technological advancement throughout the sector, is the main driver

of this improvement. The average efficiency change (Effch), on the other hand, is 0.962, suggesting aslightdecline in managerial efficiency by about 3.8%. Firm-level analysis shows that AXA France Vie achieved the highest productivity growth with a TFPch of 2.728, supported by significant improvements in both efficiency (Effch = 1.465) and technology (Techch = 1.862). GIC Re also exhibited robust productivity growth (TFPch = 1.495), mainly attributed to technological advancements (Techch = 1.513), despite a slight decline in efficiency (Effch = 0.988). RGA recorded a TFPch of 1.087, showing stable performance with balanced contributions from both efficiency and technological improvements. Similarly, Lloyd's of India and XL SE posted productivity gains, with TFPch scores of 1.074 and 1.114 respectively, reflecting steady improvements without major operational disruptions. However, with TFPch scores of 0.479, 0.899, and 0.867, respectively, Gen Re, Munich Re, and Swiss Re displayed decreases in total factor productivity. In particular, efficiency (Effch = 0.743) and technological advancement (Techch = 0.644) decreased for Gen Re, suggesting difficulties with internal management procedures as well as adjusting to new technology.

Munich Re and Swiss Re faced moderate declines largely due to management inefficiencies rather than technological stagnation.

## 4.3 Private General Insurance Companies

*DEA Analysis under CRS*

Table 4.8 summarizes the technical efficiency analysis under CRS , offering a comprehensive evaluation of the operational efficiency of 19 private general insurance companies in India over four financial years (2020–21 to 2023–24). The average technical efficiency score across all firms and years was 0.558, suggesting that, on average, private general insurers operated at only 55.8% efficiency relative to the best-practice frontier. This indicates significant room for improvement in converting inputs into outputs under the assumption of constant returns to scale. Among the insurers analyzed, Bajaj Allianz Gen., IFFCO Tokio Gen., and Shriram Gen. consistently achieved an efficiency score of 1 across all years, signifying full technical efficiency

under CRS. These firms can be considered benchmarks or role models within the sector, as they efficiently utilized their resources throughout the study period. Their sustained efficiency implies effective operational strategies, cost management, and scale optimization.

In contrast, several insurers persistently exhibited low efficiency levels. Acko Gen., Kotak Mahindra Gen., and Raheja QBE Gen. reported average efficiency scores of 0.108, 0.212, and 0.198, respectively—reflecting less than 25% efficiency. Such low performance highlights structural or managerial inefficiencies, potential under-utilization of resources, or an inability to leverage scale economies. Notably, while Navi Gen. showed low efficiency in the initial years, it reached an efficiency score of 1 in 2023–24, signaling a significant operational turnaround.

The sector's overall efficiency trend shows modest improvement, rising from 0.557 in 2020–21 to 0.689 in 2023–24. This positive trajectory suggests gradual alignment towards best practices, possibly driven by technological adoption, digitalization, and post-pandemic strategic restructuring. However, the fact that efficiency remains below 70% for the sector indicates systemic inefficiencies and unexploited scale economies under CRS.A comparison of large players like HDFC ERGO and ICICI Lombard reveals that while HDFC ERGO maintained high efficiency in the earlier years, its efficiency declined to 0.822 in 2023–24. ICICI Lombard showed improvement, increasing from 0.633 to 0.845 over the period. These dynamics may reflect shifts in underwriting strategies, expense management, or product diversification challenges.

Overall, the analysis under CRS suggests that while a few firms achieve optimal scale efficiency, the majority of India's private general insurers operate under suboptimal scale conditions. This underscores the need for strategic interventions such as process automation, better claims management, product portfolio optimization, and stronger digital channels to improve operational efficiency. Moreover, firms with persistently low efficiency must critically evaluate their cost structures, channel strategies, and underwriting practices to move closer to the efficiency frontier.

*DEA Analysis under VRS*

The analysis of technical efficiency under VRS, as presented in Table 4.9, provides valuable insights into the pure technical efficiency (managerial efficiency) of India's private general insurance companies over four years (2020–21 to 2023–24). The average efficiency score across all firms and years under VRS was 0.822, notably higher than the CRS average of 0.558, indicating that a significant portion of inefficiency observed under CRS stems from scale inefficiency rather than pure managerial shortcomings.

**TABLE 4.8 : Efficiency Scores of Private General Insurers Using CCR Model**

| No. | Insurers | 2020-21 | 2021-22 | 2022-23 | 2023-24 | Average |
|---|---|---|---|---|---|---|
| 1 | AckoGen. | .076 | .103 | .118 | .135 | .108 |
| 2 | Bajaj Allianz Gen. | 1 | 1 | 1 | 1 | 1 |
| 3 | Cholamandalam MS Gen. | .622 | .458 | .534 | .783 | .599 |
| 4 | Future Gen.i India | .332 | .303 | .283 | .500 | .354 |
| 5 | Go Digit Gen. | .301 | .297 | .284 | .565 | .362 |
| 6 | HDFC ERGO Gen. | 1 | 1 | 1 | .822 | .955 |
| 7 | ICICI Lombard Gen. | .633 | .547 | .655 | .845 | .670 |
| 8 | IFFCO Tokio Gen. | 1 | 1 | 1 | 1 | 1 |
| 9 | Kotak Mahindra Gen. | .197 | .195 | .188 | .267 | .212 |
| 10 | Liberty Gen. | .270 | .270 | .301 | .464 | .326 |
| 11 | Magma HDI Gen. | .395 | .282 | .258 | .607 | .386 |
| 12 | Navi Gen. | .080 | .072 | .247 | 1 | .350 |
| 13 | Raheja QBE Gen. | .129 | .168 | .172 | .323 | .198 |
| 14 | Reliance Gen. | 1 | .680 | .426 | .626 | .683 |
| 15 | Royal Sundaram Gen. | .536 | .488 | .457 | .632 | .528 |
| 16 | SBI Gen. | 1 | .593 | .505 | .987 | .771 |
| 17 | Shriram Gen. | 1 | 1 | 1 | 1 | 1 |
| 18 | Tata AIG Gen. | .459 | .415 | .435 | .529 | .460 |
| 19 | Universal Sompo Gen. | .557 | .464 | .547 | 1 | .642 |
| | **Average** | .557 | .491 | .495 | .689 | **.558** |

**Results calculated by the researcher**

Eight insurers—Bajaj Allianz, HDFC ERGO Gen., ICICI Lombard, IFFCO Tokio Gen., Magma HDI, Navi Gen., Raheja QBE, Shriram Insurance, and Universal Sompo—achieved a perfect efficiency score of 1 consistently across all or most years. These firms operated efficiently relative to the VRS frontier, highlighting strong managerial performance in utilizing available resources, even if they were not always scale efficient under CRS. Their consistent efficiency positions them as leaders in operational practices, process management, and adaptability within the private general

insurance sector.

Conversely, firms such as Acko, Go Digit, Future Generali, Tata AIG, and Liberty reported lower average VRS efficiency scores (ranging from 0.48 to 0.55). These findings suggest ongoing challenges in internal resource utilization, workflow optimization, or managerial processes despite being insulated from scale-related inefficiencies. Notably, Acko showed a significant decline in efficiency from 0.820 in 2020–21 to 0.174 in 2023–24, signaling potential strategic or operational disruptions requiring urgent managerial intervention.

**TABLE 4.9: Efficiency Scores of Private General Insurers Using BCC Model**

| No. | Insurers | 2020-21 | 2021-22 | 2022-23 | 2023-24 | Average |
|---|---|---|---|---|---|---|
| 1 | AckoGen. | .820 | .764 | .460 | .174 | .554 |
| 2 | Bajaj Allianz Gen. | 1 | 1 | 1 | 1 | 1 |
| 3 | Cholamandalam MS Gen. | .735 | .667 | .698 | .802 | .725 |
| 4 | Future Gen.i India | .461 | .602 | .557 | .503 | .531 |
| 5 | Go Digit Gen. | .459 | .482 | .424 | .567 | .483 |
| 6 | HDFC ERGO Gen. | 1 | 1 | 1 | 1 | 1 |
| 7 | ICICI Lombard Gen. | 1 | 1 | 1 | 1 | 1 |
| 8 | IFFCO Tokio Gen. | 1 | 1 | 1 | 1 | 1 |
| 9 | Kotak Mahindra Gen. | .919 | .892 | .675 | .391 | .719 |
| 10 | Liberty Gen. | .519 | .613 | .561 | .495 | .547 |
| 11 | Magma HDI Gen. | 1 | 1 | .959 | .977 | .984 |
| 12 | Navi Gen. | 1 | 1 | 1 | 1 | 1 |
| 13 | Raheja QBE Gen. | 1 | 1 | 1 | 1 | 1 |
| 14 | Reliance Gen. | 1 | 1 | .644 | .747 | .848 |
| 15 | Royal Sundaram Gen. | .721 | .806 | .748 | .784 | .765 |
| 16 | SBI Gen. | 1 | 1 | .859 | 1 | .965 |
| 17 | Shriram Gen. | 1 | 1 | 1 | 1 | 1 |
| 18 | Tata AIG Gen. | .461 | .452 | .483 | .559 | .489 |
| 19 | Universal Sompo Gen. | 1 | 1 | 1 | 1 | 1 |
| | **Average** | .847 | .857 | .793 | .789 | **.822** |

**Results calculated by the researcher**

A sectoral trend is observed in the efficiency scores, with average VRS efficiency slightly declining from 0.857 in 2021–22 to 0.789 in 2023–24. This shows that changes in the market, new rules, or updates in technology have made the companies' efficiency more unstable. For some insurers, the small difference between CRS and VRS efficiency scores means that to improve, they need to focus more on growing their size

properly, not just on fixing management issues.

The large number of efficient firms under VRS shows that many insurance companies have strong internal processes and work well on their own.However, their inability to achieve similar efficiency under CRS indicates under-utilization of scale economies or suboptimal market positioning. Therefore, future strategic focus should aim at expanding scale, improving market penetration, and leveraging economies of scale while sustaining managerial efficiency.

In summary, the VRS analysis reveals that while India's private general insurers perform well in managing internal resources, realizing efficiency gains from scale remains a key opportunity for long-term competitiveness and productivity improvement.

*Scale Efficiency Analysis*

The analysis of scale efficiency for India's private general insurance companies, as presented in Table 4.10, offers critical insights into whether insurers are operating at an optimal scale to fully exploit economies of scale. Scale efficiency reflects the degree to which a firm is operating at its most productive size, separating managerial inefficiency from inefficiencies due to under- or over-utilization of capacity.

The average scale efficiency across all firms and years was 0.681, implying that on average, insurers operated at 68.1% of optimal scale efficiency. This indicates a notable level of scale-related inefficiency in the sector, suggesting that many firms are not leveraging potential cost advantages or market opportunities associated with their size.

Six insurers—Bajaj Allianz Gen., HDFC ERGO Gen., IFFCO Tokio Gen., Shriram, Reliance (2020–21), and SBI Gen. (2023–24)—achieved a perfect scale efficiency score of 1 in at least one or more years, demonstrating that they operated at the most productive scale during those periods. Their ability to achieve full scale efficiency reflects well-structured operations, balanced expansion strategies, and optimized utilization of resources.

On the other side , insurers like Acko,Kotak Mahindra Gen., Raheja QBE, and Navi Gen. has persistently low scale efficiency scores, there average is below 0.35 over the

four years. And also Acko's scale efficiency improved sharply from 0.092 in 2020–21 to 0.774 in 2023–24, while Navi Gen. have score of 1 in 2023–24 after previous inefficiencies , which shows their successful scale adjustments or expansion strategies in the latter years.

Across the sector, a positive trend can be analysed by data , with average scale efficiency which was 0.662 in 2020–21 increases to 0.871 in 2023–24, suggesting a conveergence toward optimal scale. This progress is mainly due to efforts such as strategic partnerships, technological advancements, and improved market penetration strategies. These traits are adopted by insurers in the post-pandemic period.

**TABLE 4.10 Scale Efficiencies of Private General Insurers**

| No. | Insurers | 2020-21 | 2021-22 | 2022-23 | 2023-24 | Average |
|---|---|---|---|---|---|---|
| 1 | AckoGen. | .092 | .135 | .256 | .774 | .314 |
| 2 | Bajaj Allianz Gen. | 1 | 1 | 1 | 1 | 1 |
| 3 | Cholamandalam MS Gen. | .847 | .687 | .765 | .976 | .819 |
| 4 | Future Gen.i India | .720 | .502 | .507 | .994 | .681 |
| 5 | Go Digit Gen. | .654 | .617 | .670 | .997 | .735 |
| 6 | HDFC ERGO Gen. | 1 | 1 | 1 | .822 | .955 |
| 7 | ICICI Lombard Gen. | .633 | .547 | .655 | .845 | .670 |
| 8 | IFFCO Tokio Gen. | 1 | 1 | 1 | 1 | 1 |
| 9 | Kotak Mahindra Gen. | .215 | .219 | .279 | .684 | .349 |
| 10 | Liberty Gen. | .520 | .440 | .536 | .937 | .608 |
| 11 | Magma HDI Gen. | .395 | .282 | .268 | .622 | .392 |
| 12 | Navi Gen. | .080 | .072 | .247 | 1 | .350 |
| 13 | Raheja QBE Gen. | .129 | .168 | .172 | .323 | .198 |
| 14 | Reliance Gen. | 1 | .680 | .662 | .838 | .795 |
| 15 | Royal Sundaram Gen. | .744 | .606 | .611 | .806 | .692 |
| 16 | SBI Gen. | 1 | .593 | .588 | .987 | .792 |
| 17 | Shriram Gen. | 1 | 1 | 1 | 1 | 1 |
| 18 | Tata AIG Gen. | .995 | .920 | .900 | .945 | .940 |
| 19 | Universal Sompo Gen. | .557 | .464 | .547 | 1 | .642 |
| | **Average** | .662 | .575 | .614 | .871 | **.681** |

**Results calculated by the researcher**

Tata AIG and Cholamandalam MS consistently maintained high and stable scale efficiency throughout the period.This shows that their steady growth strategies are well-aligned with their market focus. On the other hand firms like Liberty General and Magma HDI showed more fluctuations in scale efficiency, that is they are facing more challenges in maintaining optimal capacity.

*Malmquist Productivity Index Analysis*

The Malmquist Productivity Index put light on how India's private general insurance sector has evolved over time.It breaks productivity changes into two key components: efficiency change (Effch) and technical change (Techch). Table 4.11 gives the geometric mean results for 19 insurance companies during 4 year period, giving insight of how these firms have progressed.

**TABLE 4.11 MPI Summary Of Private General Insurance Firm Means**

| No. | Insurers | Effch | Techch | TFPch |
|---|---|---|---|---|
| 1 | AckoGen. | .569 | 2.313 | 1.315 |
| 2 | Bajaj Allianz Gen. | 1 | 1.743 | 1.743 |
| 3 | Cholamandalam MS Gen. | 1.129 | 1.293 | 1.459 |
| 4 | Future Gen.i India | .851 | 1.547 | 1.317 |
| 5 | Go Digit Gen. | .851 | 1.402 | 1.193 |
| 6 | HDFC ERGO Gen. | .733 | 1.014 | .744 |
| 7 | ICICI Lombard Gen. | 1.068 | 1.344 | 1.436 |
| 8 | IFFCO Tokio Gen. | 1.117 | 1.311 | 1.464 |
| 9 | Kotak Mahindra Gen. | .782 | 1.690 | 1.322 |
| 10 | Liberty Gen. | .875 | 1.583 | 1.385 |
| 11 | Magma HDI Gen. | .997 | 1.185 | 1.182 |
| 12 | Navi Gen. | 1 | 2.415 | 2.415 |
| 13 | Raheja QBE Gen. | 1 | 1.440 | 1.440 |
| 14 | Reliance Gen. | .929 | .897 | .834 |
| 15 | Royal Sundaram Gen. | 1.043 | 1.129 | 1.178 |
| 16 | SBI Gen. | 1 | .908 | .908 |
| 17 | Shriram Gen. | 1 | 1.100 | 1.100 |
| 18 | Tata AIG Gen. | .948 | 1.012 | .959 |
| 19 | Universal Sompo Gen. | 1 | 1.506 | 1.506 |
| | **Average** | .931 | 1.360 | **1.265** |

**Note : Malmquist index averages are geometric means**
**Results calculated by the researcher**

The average of firm's Total Factor Productivity Change (TFPch) is 1.265, showing an overall productivity gain of 26.5% across the industry. This growth was mainly due to average technical change of 1.360, giving insight about the main role of technological change adopted by firms such as digitalization, automation in work, and

process improvement and innovations. On the other hand, the average efficiency change was 0.931, that is a 6.9% drop in relative efficiency over the period. This show that inspite of the industry made significant growth in technology, insurers have faced challenges in changing inputs into outputs effectively and also maintaining or improving it.

HDFC ERGO, Reliance, SBI, and Tata AIG all reported TFPch values below 1.0, means a decline in productivity over the period. For HDFC ERGO (TFPch = 0.744), this drop is due to reduced efficiency (Effch = 0.733) and minimal technological progress (Techch = 1.014). Similarly, Reliance saw its productivity fall (TFPch = 0.834), driven by technological setbacks (Techch = 0.897) along with a slight dip in efficiency (Effch = 0.929).These findings imply challenges in sustaining innovation or adapting to technological shifts, potentially exacerbated by competitive and regulatory pressures.

The Malmquist Productivity Index shows that India's private general insurance sector has made good progress in productivity, mostly because of better technology, not because of improved efficiency. To stay competitive in the future, insurers need to not only rely on new technology but also focus on working more efficiently. This means making sure new ideas are used properly in daily work, processes, and decision-making.

# CHAPTER 5

# CONCLUSION, LIMITATION AND FUTURE IMPLICATIONS

## 5.1 Conclusion

This study takes a deep dive into how efficiently Indian general insurers and reinsurers have been operating in last 5 years. By applying tools like Data Envelopment Analysis (DEA) and the Malmquist Productivity Index, it analyse how efficiency changes over a period of time. This also highlighting key differences in efficiency among companies, industry segments, and across various time frames.

### 5.1.1 Conclusion on General Insurance Companies

The DEA (Data Envelopment Analysis) findings for general insurance companies gave efficiency score for each general insurance companies which show a large gap between their scores. Public sector firms like The New India Assurance have full efficiency of 1 and it performed well throughout the study period. This suggests they have good internal management and are operating at the right scale. On the other hand, many private and newly launched insurance companies, despite focusing on innovation, were less efficient. Their lower scores were mostly due to issues like not using resources properly and also due to their size.

The average technical efficiency under the CRS model hovered around 59%, highlighting significant room for improvement in resource allocation and process streamlining. The VRS-based analysis further clarified that many inefficiencies stemmed more from firm size than managerial underperformance. Scale efficiency analysis pointed out that numerous insurers are operating either below or above the ideal scale, affecting their cost-effectiveness and competitiveness.

### 5.1.2 Conclusion on Reinsurance Companies

For reinsurers, the findings were similarly mixed. **GIC Re**, India's flagship public reinsurer, consistently achieved full efficiency, reflecting robust governance, effective scale, and deep market experience. Among foreign reinsurers, firms like **RGA** and **AXA France Vie** demonstrated consistently high technical and pure technical efficiency, suggesting successful adaptation to the Indian regulatory and market environment.

However, a group of reinsurers including **Swiss Re**, **SCOR SE**, and **Lloyd's of India** exhibited persistent inefficiencies. While some of these inefficiencies were linked to operational scale, others were driven by suboptimal internal management and underutilization of resources.

The Malmquist Productivity Index gave a more dynamic view of the results. It clearly showed that most of the productivity growth in the reinsurance sector came from improvements in technology. However, gains in efficiency were not as strong as compared to technological efficiency change. This means that while companies are adopting new technologies, they still need to improve their internal processes and decision-making to truly benefit from these advancements and turn them into real performance improvements.

### 5.1.3 Conclusion on Private General Insurance Companies

This study takes a close look at how efficient and productive India's private general insurance sector is. It uses a combined method with the Slack-Based Measure Data Envelopment Analysis (SBM-DEA) and the Malmquist Productivity Index. By studying both current performance and how it has changed over time, the research gives useful insights into how well companies are running, how effectively they are growing, and the long-term trends in their productivity.

So, what did we find? First, there are big differences in efficiency levels between insurance companies, whether we look at constant returns to scale (CRS) or variable returns to scale (VRS). A few top performers—like Bajaj Allianz, IFFCO Tokio, and Shriram General Insurance—kept showing full efficiency, setting a good example for others. But most companies are still not doing well, especially under CRS. This shows a clear problem: many firms are not using their size effectively, which is holding back their overall performance.

Digging deeper, the scale efficiency analysis shows that many insurers still haven't reached their optimal operational size. The good news? We're seeing gradual improvements—a sign that efforts around consolidation, adopting new technologies, and expanding market presence are starting to pay off. But there's still plenty of room to grow, especially when it comes to making the most of economies of scale.

The productivity story is equally telling. The Malmquist Productivity Index shows that the sector has indeed seen productivity gains—but these have been driven mainly by technological progress rather than better management practices. In other words, while tech investments are pushing the frontier forward, many insurers are struggling to turn these investments into real, on-the-ground operational improvements.

The big takeaway? Technology alone isn't enough. Sustainable gains in efficiency and productivity will only come when insurers align their tech upgrades with stronger managerial processes and smarter operational strategies.

For policymakers and insurance leaders, the message is clear: it's time to focus not just on expanding and innovating but also on fine-tuning operations, optimizing scale, and fostering a culture of continuous improvement. These steps will be crucial for staying competitive in a fast-evolving insurance market.

## 5.2 Limitations

This study offers useful insights into how efficient Indian general insurers and reinsurers are. These are some limitations:

1. **Data Availability and Scope**: The analysis relies exclusively on secondary data obtained from public sources such as IRDAI annual reports. Some critical inputs, like labor or technological investments, were not available and had to be approximated through financial proxies such as operating expenses and commissions.
2. **Static Input Selection**: Although the study uses statistical methods like correlation and regression analysis to select inputs and outputs, these selections are based on available financial indicators. Non-financial performance dimensions, such as customer satisfaction or digital maturity, are not considered due to data unavailability.
3. **Assumption of Homogeneity**: DEA assumes that all Decision Making Units (DMUs) operate in comparable environments. However, variations in business models, market share, and regulatory exposure among insurers and reinsurers might impact results but are not explicitly adjusted for.
4. **Technological and Regulatory Lag**: The Malmquist Productivity Index identifies trends in technological progress and efficiency changes but does not delve into the specific innovations or policy reforms driving those shifts, which limits the actionable interpretation of productivity sources.

Despite these limitations, the study maintains analytical robustness and provides a meaningful foundation for further research on performance evaluation in the insurance and reinsurance sectors.

## 5.3 Future Scope and Social Impact

### 5.3.1 Future Scope

The findings of this study open several avenues for extended research and application in the evolving insurance and reinsurance landscape:

1. **Integration of Non-Financial Indicators**: Future studies could incorporate qualitative factors such as digital maturity, customer grievance handling effectiveness, and employee efficiency, which are increasingly important in gauging true organizational performance.
2. **Incorporating Advanced DEA Models**: Expanding this work using dynamic DEA models, network DEA, or bootstrapped DEA could improve result accuracy and provide richer insights, particularly in analyzing cause-effect relationships over time.
3. **Cross-Country Efficiency Comparisons**: Comparative studies between Indian insurers and their international counterparts could highlight global best practices and reveal areas where Indian firms may need strategic realignment.
4. **Impact of Policy and Regulatory Shifts**: Further exploration of the role of specific regulatory changes—such as solvency norms, digital mandates, or foreign investment caps—could offer actionable policy insights and enhance the strategic adaptability of insurers.
5. **Inclusion of ESG Metrics**: As Environmental, Social, and Governance (ESG) parameters gain traction, future efficiency models could integrate sustainability indicators to assess long-term viability and stakeholder alignment.

### 5.3.2 Social Impact

The results of this research have several important meanings for both society and the larger financial system:

- **Building Customer Trust:** Insurers and reinsurers that run efficiently are more likely to settle claims quickly, giving people the financial support they need—especially during tough times like pandemics or natural disasters.

- **Stronger Economy and Market Stability:** When insurance companies work efficiently, the whole industry becomes more stable. This helps businesses manage risks better and supports the country's overall economic growth.

- **Better Use of Public Resources:** The study's findings on inefficiencies in government-owned insurers can help shape reforms. This means taxpayer money can be used more wisely, and public services can improve.

- **Stronger Rules and Regulations:** The results can help regulators like IRDAI (Insurance Regulatory and Development Authority of India) make better, data-based policies. This would lead to a more fair, transparent, and competitive insurance sector.

- **Reaching More People:** Fixing inefficiencies can allow insurance companies to grow sustainably and reach people in rural and smaller towns, helping more citizens get access to financial protection.

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# Delhi Technological University

(Formerly Delhi College of Engineering)

**THE RESULT OF THE CANDIDATE WHO APPEARED IN THE FOLLOWING EXAMINATION HELD IN NOV 2023 IS DECLARED AS UNDER:-**

## Master of Technology(Industrial Engineering and Management), I-SEMESTER

**Result Declaration Date : 04-03-2024** **Notification No: 1660**

IEM501 : Data Analytics IEM503 : Production & Operation Management IEM5205 : Principles of Managment IEM5305 : Total Quality Management IEM5407 : Product Design & Development

| Sr.No | Roll No. | Name of Student | IEM501 | IEM503 | IEM5205 | IEM5305 | IEM5407 | SGPA | TC | CGPA | Failed Courses |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 4.00 | 4.00 | 2.00 | 3.00 | 4.00 | | | | |
| 1 | 23/IEM/01 | RAVI RANJAN | F | F | A+ | O | A+ | 6.46 | 9 | ... | IEM501 |
| 2 | 23/IEM/02 | AATIF AMEER | O | B+ | A+ | O | O | 9.18 | 17 | 9.176 | |
| 3 | 23/IEM/03 | MAHESH SAROHA | A+ | A | A | A | O | 8.71 | 17 | 8.706 | |
| 4 | 23/IEM/04 | REDDI DUSHYANTH VENKATA SAI KRISHNA | A+ | B+ | A+ | A | A | 8.12 | 17 | 8.118 | |
| 5 | 23/IEM/05 | DIVYANSH | C | C | A | C | B+ | 5.82 | 17 | 5.824 | |
| 6 | 23/IEM/06 | RAJENDER | A+ | B | A | A | A | 7.76 | 17 | 7.765 | |
| 7 | 23/IEM/07 | PIYUSH KUMAR | A+ | B | A+ | B | A | 7.53 | 17 | 7.529 | |
| 8 | 23/IEM/08 | ISHAN KOTNALA | C | F | B | C | B | 4.18 | 13 | ... | IEM503 |
| 9 | 23/IEM/09 | LOKESH KUMAR | A+ | B+ | A+ | B+ | A | 7.94 | 17 | 7.941 | |
| 10 | 23/IEM/10 | DHRUV SHANKAR SAXENA | A+ | A | O | O | A+ | 9.06 | 17 | 9.059 | |
| 11 | 23/IEM/11 | SHISHIR | A+ | A+ | A+ | A+ | A+ | 9 | 17 | 9 | |
| 12 | 23/IEM/12 | MORIE MEYER KOUNA FERRAND | C | P | B+ | B | B+ | 5.65 | 17 | 5.647 | |
| 13 | 23/IEM/13 | FREDRICK KABWE | C | B | A | B+ | B+ | 6.41 | 17 | 6.412 | |

IEM501 : Data Analytics

| Sr.No | Roll No. | Name of Student | IEM501 | SGPA | TC | CGPA | Failed Courses |
|---|---|---|---|---|---|---|---|
| | | | 4.00 | | | | |
| 14 | 23/IEM/501 | PRAMOD | C | 5 | 4 | 5 | |

**OIC (Results)**

**Controller of Examination**

**Note:**Any discrepancy in the result in r/o name/roll no/registration/marks/grades/course code/title should be brought to the notice of Controller of Examination/OIC(Results) within 15 days of declaration of result in the prescribed proforma.

# Delhi Technological University

(Formerly Delhi College of Engineering)

**THE RESULT OF THE CANDIDATE WHO APPEARED IN THE FOLLOWING EXAMINATION HELD IN MAY 2024 IS DECLARED AS UNDER:-**

## Master of Technology(Industrial Engineering and Management), II-SEMESTER

**Result Declaration Date : 16-07-2024** **Notification No: 1691**

IEM502 : OPERATIONS RESEARCH

| Sr.No | Roll No. | Name of Student | IEM502 | SGPA | TC | Failed Courses |
|---|---|---|---|---|---|---|
| | | | 4.00 | | | |
| 1 | 23/IEM/501 | PRAMOD | C | 5 | 4 | |

IEM502 : OPERATIONS RESEARCH IEM504 : SUPPLY CHAIN MANAGEMENT IEM5210 : Contemporary Issues in Industrial Engineering and Managment IEM5304 : International Logistics and Warehouse Managment IEM5404 : INDUSTRY 4.0 & SMART MANUFACTURING

| Sr.No | Roll No. | Name of Student | IEM502 | IEM504 | IEM5210 | IEM5304 | IEM5404 | SGPA | TC | Failed Courses |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 4.00 | 4.00 | 2.00 | 3.00 | 4.00 | | | |
| 2 | 23/IEM/01 | RAVI RANJAN | O | B+ | A+ | A | O | 8.82 | 17 | |
| 3 | 23/IEM/02 | AATIF AMEER | A+ | B+ | O | A+ | A+ | 8.65 | 17 | |
| 4 | 23/IEM/03 | MAHESH SAROHA | O | A | A | A+ | A+ | 8.88 | 17 | |
| 5 | 23/IEM/04 | REDDI DUSHYANTH VENKATA SAI KRISHNA | A+ | B | A | A | A+ | 8 | 17 | |
| 6 | 23/IEM/05 | DIVYANSH | B+ | P | B | B+ | A+ | 6.65 | 17 | |
| 7 | 23/IEM/06 | RAJENDER | A+ | B | A | A | O | 8.24 | 17 | |
| 8 | 23/IEM/07 | PIYUSH KUMAR | A | B | A | A | O | 8 | 17 | |
| 9 | 23/IEM/08 | ISHAN KOTNALA | P | C | B+ | B+ | A | 6.06 | 17 | |
| 10 | 23/IEM/09 | LOKESH KUMAR | A+ | A | A+ | A+ | A+ | 8.76 | 17 | |
| 11 | 23/IEM/10 | DHRUV SHANKAR SAXENA | A+ | A | O | O | O | 9.29 | 17 | |
| 12 | 23/IEM/11 | SHISHIR ACHARYA | A+ | A | A | A+ | O | 8.88 | 17 | |
| 13 | 23/IEM/12 | MORIE MEYER KOUNA FERRAND | A | C | A | A | A | 7.29 | 17 | |
| 14 | 23/IEM/13 | FREDRICK KABWE | A | B | A | A | A | 7.53 | 17 | |

**OIC (Results)** **Controller of Examination**

**Note:**Any discrepancy in the result in r/o name/roll no/registration/marks/grades/course code/title should be brought to the notice of Controller of Examination/OIC(Results) within 15 days of declaration of result in the prescribed proforma.

# Delhi Technological University

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**THE RESULT OF THE CANDIDATE WHO APPEARED IN THE FOLLOWING EXAMINATION HELD IN Summer Semester 2024 IS DECLARED AS UNDER:-**

## Master of Technology(Industrial Engineering and Management), I-SEMESTER

**Result Declaration Date : 17-05-2025** **Notification No: 1826**

IEM501 : Data Analytics IEM503 : Production & Operation Management

| Sr.No | Roll No. | Name of Student | IEM501 | IEM503 | Failed Courses |
|---|---|---|---|---|---|
| | | | 4.00 | 4.00 | |
| 1 | 23/IEM/01 | RAVI RANJAN | B+ | A | |
| 2 | 23/IEM/08 | ISHAN KOTNALA | C | P | |

**OIC (Results)**

**Controller of Examination**

**Note:**Any discrepancy in the result in r/o name/roll no/registration/marks/grades/course code/title should be brought to the notice of Controller of Examination/OIC(Results) within 15 days of declaration of result, in the prescribed proforma.

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**THE RESULT OF THE CANDIDATE WHO APPEARED IN THE FOLLOWING EXAMINATION HELD IN NOV 2024 IS DECLARED AS UNDER:-**

## Master of Technology(Industrial Engineering and Management), III-SEMESTER

**Result Declaration Date : 12-03-2025** **Notification No: 1798**

IEM5205 : Principles of Managment IEM5305 : Total Quality Management

| Sr.No | Roll No. | Name of Student | IEM5205 | IEM5305 | SGPA | TC | Failed Courses |
|---|---|---|---|---|---|---|---|
| | | | 2.00 | 3.00 | | | |
| 1 | 23/IEM/501 | PRAMOD | B+ | C | 5.8 | 5 | |

IEM601 : MAJOR PROJECT I IEM6201 : E- Commerce IEM6305 : GLOBAL BUSINESS MANAGEMENT IEM6405 : Advanced Operation Research

| Sr.No | Roll No. | Name of Student | IEM601 | IEM6201 | IEM6305 | IEM6405 | SGPA | TC | Failed Courses |
|---|---|---|---|---|---|---|---|---|---|
| | | | 3.00 | 2.00 | 3.00 | 4.00 | | | |
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| 1 | Efficiency Evaluation of General Insurance Companies: A Data Envelopment Analysis based Study | Presented in ICRAMEN 2025 and accepted for publishing in the AIP Conference Proceedings (Scopus Index), having **ISSN:** 0094-243X (print), 1551-7616 (web) |
| 2 | Performance Assessment of Indian Reinsurers Using SBM-DEA and Malmquist Approach | Presented in ICRAMEN 2025 and accepted for publishing in the AIP Conference Proceedings (Scopus Index), having **ISSN:** 0094-243X (print); 1551-7616 (web) |
| 3 | Strategic Efficiency and Productivity Analysis of India's Private General Insurers-using SBM-DEA and the Malmquist Index | Presented in ICIRSTSD 2025 and accepted for publishing in the WOS(Springer) Conference Proceedings. |

Gmail

Ravi Pandey <rrp7070@gmail.com>

# ICRAMEN2025: Acceptance Letter - Paper Id: 069_RANJAN_ICRAMEN2025

**conference.rame@gmail.com** <conference.rame@gmail.com> Thu, Apr 17, 2025 at 12:18 PM
To: rrp7070@gmail.com

Paper Title: Efficiency Evaluation of General Insurance Companies: A Data Envelopment Analysis based Study
Paper Id: 069_RANJAN_ICRAMEN2025
Authors: RAVI RANJAN,PRAVIN KUMAR

Dear Authors,
Congratulations! We are pleased to inform you that your paper has been ACCEPTED for oral presentation at 5th International Conference on Mechanical Engineering and Nanomaterials (ICRAMEN 2025) to be held by St. John College of Engineering and Management, Palghar in association with Research Association of Masters in Engineering, Pune, Maharashtra, India during May 16-17, 2025.

Registration:
Confirmation of your presentation on the final schedule is contingent upon receipt of the presenting author's registration and full payment of the registration charges. Presenters must attend and present the paper in online mode in order to be included in the program and proceedings.
The fees for the conference registration and payment instructions details can be found at https://icramen.rame.org.in/2025/registration/

Presentation Guidelines
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Best Regards
Organizing Committee
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**ICRAMEN2025: Acceptance Letter - Paper Id: 069_RANJAN_ICRAMEN2025.pdf**
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# ICRAMEN2025: Acceptance Letter - Paper Id: 107_RANJAN_ICRAMEN2025

1 message

**conference.rame@gmail.com** <conference.rame@gmail.com> Thu, May 1, 2025 at 1:48 AM
To: rrp7070@gmail.com

Paper Title: Performance Assessment of Indian Reinsurers Using SBM-DEA and Malmquist Approach
Paper Id: 107_RANJAN_ICRAMEN2025
Authors: Ravi Ranjan, Pravin Kumar

Dear Authors,
Congratulations! We are pleased to inform you that your paper has been ACCEPTED for oral presentation at 5th International Conference on Mechanical Engineering and Nanomaterials (ICRAMEN 2025) to be held by St. John College of Engineering and Management, Palghar in association with Research Association of Masters in Engineering, Pune, Maharashtra, India during May 16-17, 2025.

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# Acceptance of Abstract (Paper ID: 3.21)

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**Conference SoS OPJU** <conference.sos@opju.ac.in> Wed, Apr 30, 2025 at 2:36 PM
To: Ravi Pandey <rrp7070@gmail.com>

Dear **Ravi Ranjan,**

Greetings from the **School of Sciences, OP Jindal University, Raigarh!**

We are pleased to inform you that your abstract titled **"Strategic Efficiency and Productivity Analysis of India's Private General Insurers- using SBM-DEA and the Malmquist Index"** has been **accepted** for presentation at the **4th International Conference on Innovation & Research in Science and Technology for Sustainable Development**, to be held on **May 29th & 30th, 2025**, at **OP Jindal University, Raigarh.**

To facilitate the publication process, we kindly request you to submit your **full-length paper** by **May 10th, 2025**. Please ensure that you complete the **registration process** as soon as possible as a mark of confirmation.

Please do not hesitate to contact us at conference.sos@opju.ac.in and visit our website (**https://www.opju.ac.in/ICIRSTSD/**) for further details.

*We look forward to your valuable contribution and an engaging exchange of knowledge at the conference.*

Best regards,
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# Efficiency Evaluation of General Insurance Companies: A Data Envelopment Analysis based Study

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[1,2]*Department of Mechanical Engineering, Delhi Technological University, Shahbad Road New Delhi, India – 110042*
Email: [a)] rrp7070@gmail.com , [b)]pravin@dce.ac.in
Contact: [1]8810332545

**Abstract**

This study investigates the operational efficiency of general insurance companies in India from 2020 to 2024 using Data Envelopment Analysis (DEA). In light of the sector's post-liberalization expansion and the rising complexities driven by COVID-19, regulatory changes, and digital transformation, evaluating efficiency has become increasingly critical. The study employs Constant Returns to Scale (CRS) along with Variable Returns to Scale (VRS).DEA models to analyze technical and scale efficiency across several insurers. Input and output variables were considered through correlation and regression analyses to ensure model robustness, with key financial indicators such as commission, operating expenses, equity, net premiums earned, and investment income driving the analysis. Results reveal a significant gap in average technical efficiency under CRS (0.586) versus VRS (0.744), indicating prevalent scale inefficiencies.

**Keywords:** Data Envelopment Analysis, Regression, Correlation, Technical Efficiencies, Indian General Insurance.

**ICRAMEN_2025_107**

# Performance Assessment of Indian Reinsurers Using SBM-DEA and Malmquist Approach

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[1,2]Department of Mechanical Engineering, Delhi Technological University, Shahbad
New Delhi, India – 110042
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Contact: [1]8810332545

**Abstract**

This research assesses the operational efficiency and productivity dynamics of Indian reinsurers from 2019 to 2024 using the Slacks-Based Measure Data Envelopment Analysis (SBM-DEA) and Malmquist Productivity Index. This research assesses 11 reinsurers including domestic and foreign entities to identify performance drivers and inefficiencies. Employing SBM-DEA under Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS), the study measures technical efficiency, pure technical efficiency, and scale efficiency, while the Malmquist Index breaks down productivity changes into efficiency catch-up and technological progress. Key findings reveal that GIC Re, India's sole public-sector reinsurer, consistently achieved full technical efficiency (1.0), underscoring its scale advantages and operational dominance. Foreign reinsurers such as AXA France Vie (average TE = 0.929) and RGA (0.996) demonstrated near-optimal efficiency, leveraging global expertise, while others like Lloyd's India (average TE = 0.382) lagged due to chronic scale mismatches. Scale efficiency analysis highlighted that 70% of inefficiencies under CRS stemmed from suboptimal firm size rather than managerial shortcomings. The Malmquist results indicated a 10.7% total productivity growth (TFPch = 1.107), driven predominantly by technological advancements (Techch = 1.151), though managerial efficiency slightly declined (Effch = 0.962). The study underscores the dual imperative of technological adoption and operational scale optimization for sustained competitiveness. This research gives knowledge about growing markets by using advanced methods to measure efficiency and analyse productivity changes over a time period. It helps with ideas to strengthen and improve India's changing reinsurance industry.

**Keywords:** Slacks-Based Measure Data Envelopment Analysis (SBM-DEA), Malmquist Productivity Index, Indian Reinsurers, Technical Efficiency, Scale Efficiency.

# 5th International Conference on Recent Advances in Mechanical Engineering and Nanomaterials 16-17 May, 2025

In Association with RESEARCH ASSOCIATION OF MASTERS IN ENGINEERING, INDIA
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02. Enrolment No .... 23/IEM/01

03. Year of Admission .... 2023

04. Programme M.Tech., Branch.. INDUSTRIAL ENGINEERING & MANAGEMENT

05. Name of Department.... MECHANICAL

06. Admission Category i.e. Full Time/ Full Time (Sponsored)/ Part Time:.... FULL TIME

07. Applied as Regular/ Ex-student..... REGULAR

08. Span Period Expired on ..... N.A

09. Extension of Span Period Granted or Not Granted ( if applicable )..... NA

10. Title of Thesis/Major Project... An Efficiency Analysis of Indian Reinsurers and General Insurers Using Data Envelopment Analysis

11. Name of Supervisor..... Prof. Pravin Kumar

12. Result Details (Enclose Copy of Mark sheets of all semesters) :

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