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An Empirical Examination Of Digital Infrastructure Investment And Cost Efficiency In The Indian General Insurance Sector

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ABSTRACT

The insurance sector has been highly restrictive in adapting to the digitalisation happening around the globe. However, the emergence of Industry 4.0 has pushed insurance companies towards integrating ICT (Information & Communication Technology) into their business operations to remain competitive and meet client expectations. This technological shift demands a strategically developed and well-managed digital infrastructure to deploy future opportunities. Considering this phenomenon, this study aims to evaluate the relationship between the investments made in procuring digital infrastructure and the efficiency scores of the general insurance companies. A non-parametric Data Envelopment Approach (DEA) is used to evaluate the cost-efficiency scores of each company for the observation period by using the Malmquist index. Correlation is used to test the relationship between digital investment and efficiency scores. The results indicate an improvement in the technical and scale efficiency of the in-sampled general insurance companies over the observation period. It also shows a negative relationship between the two variables. The study concludes that despite a gradual increase in IT (Information Technology) investments, IT investments have no role in improving the efficiency scores of Indian general insurance companies.

Keywords: Indian insurance sector; General Insurance; Data Envelopment Approach (DEA); Information Technology (IT) investments; Efficiency.

INTRODUCTION

For any economy to progress on a global scale, it has become a mandate to own a well-developed and efficient insurance industry. Both the life insurance and the general (or non-life) insurance sector form a part of this industry. They play a key role in the development and stability of an economy. However, with the rising cost of financial resources and health care, the growing importance of an established general

insurance industry for a developing economy cannot be denied. General insurance primarily covers health, fire, marine, property, liability, aviation, terrorism and other kinds of protection against any risk or liability. Such a broad spectrum of the general insurance components adds to its importance for an economy especially, for a developing economy like India.

In 1973, the Indian general insurance industry was nationalised, resulting in the formation of four public general insurance companies. In the 1990s, when India adopted an open economy model, the state allowed the entry of private general insurance companies after deregulating the general insurance sector in 1999. After the liberalisation phase, the Indian insurance sector has undergone many regulatory and structural changes, and the last two decades have shown exponential growth in the insurance sector. Indian general insurance industry ranks 14th in the world (Source: irda.gov.in). As per the latest Insurance Regulatory and Development Authority of India (IRDAI) data, India's share in the global non-life insurance market remains relatively small, reflecting ongoing under-penetration compared with other major economies. India's overall non-life insurance industry has seen moderate growth in premium collections, expanding by over 12 per cent in 2023-24 and continuing growth into 2025, compared with stronger global trends in the broader insurance sector. In contrast to global performance, the composition of the Indian insurance market continues to be dominated by life insurance, with the life segment accounting for a significantly larger share of total premium income than non-life business. According to the most recent IRDAI annual report, life insurance premiums accounted for the majority of total premium income in 2023-24, while non-life insurance constituted a much smaller proportion of total industry premiums. Additionally, insurance penetration in India remains well below global averages, with total insurance premiums equal to only about 3.7 per cent of GDP, including roughly 2.8 per cent for life insurance and around 1 per cent for non-life insurance in FY 2023-24 — considerably lower than the global average penetration of around 7 per cent. These figures collectively underscore that the Indian general (non-life) insurance sector remains underdeveloped relative to global peers and highlights the significant potential for growth, especially in reaching the large under-insured population across the country.

Routine operations of an insurance business include offering financial protection against a potential loss and compensatory services in lieu of such losses. To offer these services efficiently, insurance companies need to understand how to control the occurrence of accidental events and simultaneously increase their market share. However, the storm of information and communication technology (ICT) adoption has changed the working style of industries worldwide. Still, the insurance sector needs to catch up in the race to adopt these technological changes and make new structural changes to deploy the opportunities offered by technological innovations and advancements. However, due to the emergence of Industry 4.0, ICT integration into business operations has become necessary for the insurers to remain competitive and meet client expectations. ICT has increased the demand and global reach of insurance services. Digital technologies like big data, artificial intelligence (AI), Cloud computing, the internet of things (IoT), and distributed ledger technologies can be strategically important for insurance companies. However, the implementation of these digital technologies demands a well-managed digital infrastructure. Digital

infrastructure provides an environment for an organisation's information technology and operations. **(Eckert & Osterrieder, 2020)** conducted a study to provide an overview of how digitalization affects the working of insurance companies and explained the use of new-age digital technologies in the insurance sector to develop customer-centric products and services by implementing enhanced customer segmentation and targeting methods or tailored underwriting and pricing, more accurate risk prediction and digital claims processing and online consultation. To implement these technologies, insurance companies should have sufficiently invested in creating digital infrastructure and strategic management to deploy the technological resources to their full potential. **(Klapkiv & Kedra, 2022)** conducted a study by analysing the main production cost indicators (acquisition, claims handling and wages) and expenditures on information technologies in the insurance companies and found out that there are no clear relations between the raising of direct insurance production costs and the demand for information technologies among insurers. This study remains the motivation for the current study that tries to analyse the efficiency scores of the Indian general insurance sector for the period of 2011-12 to 2020-21 by using the DEA and then associating them to the company's expenditure on the information technologies to devise whether there is some link between the efficiency scores of the insurance companies and their spending on digital infrastructure as **(Eckert & Osterrieder, 2020)** claims that in the long term there are benefits regarding cost savings and a sharp rise in efficiency and effectivity.

LITERATURE REVIEW

Studies on Indian General Insurance Efficiency

Researchers around the globe conduct various national and international cost-efficiency studies on the insurance sector. However, only a limited number of studies on efficiency and productivity are available for the Indian insurance sector, particularly the non-life segment, in comparison to European and American countries. Within the Indian insurance literature, **Sinha (2007, 2009, 2017a, 2017b, 2017c)** has made a notable contribution to the study of efficiency in the general insurance sector**.**

Sinha (2007) attempted to calculate the productivity and efficiency of the Indian general insurance sector. **Sinha (2009)** measured the technical efficiency of general insurance companies using slacks based super efficiency model and analysed how efficiency scores varied year by year. **Sinha (2017a)** applied bootstrap DEA to measure the technical efficiency of public and private general insurance companies and then analysed the relationship between solvency and insurers' efficiency using regression analysis. **Sinha (2017b)** evaluated the performance of 15 general insurance companies, measured the efficiency scores of the general insurers, and found that there is a strong association between efficiency and solvency. Using data envelopment analysis, **Sinha (2017c)** examined the prospective gains from the merger of public sector general insurers and concluded that efficiency gains were negative in both years as a result of a pronounced negative scale effect.

Bawa and Ruchita (2011) applied data envelopment analysis to measure the efficiency of health insurance–providing general insurers and observed that private sector firms operate with increasing returns to scale, thereby gaining from pure technical and scale efficiency.

Dutta (2013) analysed the productivity changes in Indian life and non-life insurance business with the application of non-parametric Malmquist indices and found that total factor productivity decreased in the life insurance business during the study period. However, it increased in the case of the non-life insurance business.

Mandal & Ghosh (**2014)** investigated the efficiency scores of the Indian general insurance companies using DEA and subsequently assessed the impact of the global slowdown on the performance of the allied sector. The study concluded that the global economic slowdown significantly impacted the performance of private sector insurers. In contrast, public sector insurers exhibited comparatively lesser variation in their performance levels.

Rao & Venkateswarlu (2014) evaluated the efficiency scores of the non-life insurance companies using stochastic frontier approach and ranked the insurers based on their efficiency scores. The study concluded that the efficiency levels of the Indian general insurance sector are increasing yearly.

Mandal and Dastidar (2014) conducted an efficiency analysis of the Indian general insurance sector through data envelopment analysis and concluded that the global economic slowdown had a pronounced negative impact on private insurers, whereas public sector companies experienced relatively lower performance variability.

Bawa & Kaur (2014) explored the relationship between technical efficiency (TE) and profitability in the Indian public general insurers before and after the Liberalization Privatization Globalization (LPG) era. It was revealed that the insurers' performance was relatively superior in the pre-reform period, owing to reduced levels of resource wastage.

Using non-parametric data envelopment analysis, **Chakraborty (2016)** analysed the efficiency and productivity of India's four major public sector general insurers against the backdrop of the 2007–08 US financial crisis. The results revealed that United India Insurance Company achieved the highest technical and scale efficiency, whereas National Insurance Company recorded the highest productivity among the firms studied.

Chakraborty (2018) evaluated the technical efficiency, scale efficiency, and total factor productivity of 12 general insurance firms in India by employing a two-input, two-output DEA framework along with the Malmquist TFP index. The study found that public sector general insurers recorded higher mean technical and scale efficiency scores compared to private sector insurers.

Ilyas and Rajasekaran (2019) assessed the efficiency, productivity, and returns-to-scale economies of the Indian general insurance sector by employing a two-stage data envelopment analysis bootstrap methodology to estimate efficiency and its determinants. The study concluded that the Indian non-life

insurance sector is moderately technical, scale, cost and allocative efficient. The results revealed that all the insurers, irrespective of size and ownership type, are operating under increasing returns to scale. However, public insurers are more cost-efficient than private insurers.

Sinha (2022) derived the profit efficiency scores of the Indian general insurers and then decomposed the scores into revenue and cost efficiency components. The outcome showed that the public sector insurers had done well in terms of revenue efficiency but needed to be concerned about cost efficiency.

Banker, R. D et.al (2024) focuses on estimating managerial ability in the context of the Indian and Iranian general insurance sectors. The findings reveal that the mean technical and output allocative efficiencies and managerial ability of Iranian markets highly fluctuated with a high variance. In contrast, these indicators did not fluctuate much in India.

The study attempts to take in the following objectives:

- To evaluate the efficiency scores of Indian general insurance companies.
- To test whether the investment in digital infrastructure made by general insurance companies correlates with their efficiency scores.

Hypotheses Development

The hypothesis is drawn from a general question that if there is a correlation between the efficiency scores of the insurance companies and their investments in IT infrastructure. Looking back at the initial years of 2011-2020, when the urgency of digital adoption pushed the whole world to adapt to these technological changes, the insurance industry has always lagged in digital adoption. Technological innovations and IT have digitalised every industry's working process and made the processes more efficient. With the use of ICT, insurance companies can create a digital platform and sell insurance products, manage claim settlements online, use communication technologies like chatbots to communicate between management and sales agents and customers, use advanced software to predict the risk probability better and calculate premiums with more accuracy, which can considerably impact the operating expenses and revenue. A few studies correlate and establish a link between the investments in IT infrastructure and the financial performance of insurance companies. **Francalanci and Galal (1998**) investigated the impact of changes in IT investments on the productivity of US life insurers**. Harris and Katz (1991)** calculated the ratio between the IT and Operating expenses of large and small insurers.

This study attempts to test the correlation between the efficiency scores of the general insurance companies and their IT investments to build digital infrastructure, therefore, the following hypothesis is formulated:

Ho: There is no relationship between the efficiency scores of the Indian general insurers and the IT investments during 2011-12 to 2020-21.

RESEARCH METHODOLOGY

The insurance sector's efficiency can be calculated by using a parametric as well as a non-parametric approach. The most used methods for evaluating the efficiency scores in the insurance sector are stochastic frontier analysis (parametric approach) and the data envelopment approach (DEA) (non-parametric approach). The present study opts for the non-parametric DEA as it applies the Malmquist index to evaluate the efficiency scores which correspond with the DEA. A two-stage methodology is employed in this study. The first stage estimates the cost efficiency of each insurer across the observation period using DEA, while the second stage analyses the association between the efficiency scores and investments in digital infrastructure. To establish the linkage between the efficiency scores and the IT investments, the net block of the software in the company and amount of IT equipment are taken form the financial statements of the insurers as they do not disclose the ICT parameters comprehensively in their annual reports.

Variables taken under the study

The DEA requires the specification of inputs and outputs used in the production process of a decision-making unit (DMU). Two inputs (commission and operating expenses) are taken for the study, which consists of the primary input to the insurer as they do not require raw materials for manufacturing. However, they are a part of the financial services industry, and the net premiums earned is taken as the output to the insurers. The data for the commission expenses, operating expenses and net premium earned is collected from the revenue account of each insurer for each year.

Net Premiums earned (y): Various studies consider premium as a suitable indication of production as it is assumed that the product is homogenous and that competitive forces force all insurers to set their prices at the same level. Hence, net premiums earned are considered the primary output for the insurance companies as they indicate the amount of business procured by the insurers.

Commission expenses (x1): Commission expenses refer to the commissions and remuneration paid to various intermediaries, including individual agents, corporate agents, brokers, web aggregators, insurance marketing firms, and micro agents, all of whom play a vital role in business acquisition. For analytical purposes, net commission expenses are taken into account.

Operating expenses (x2): Operating expenses consist of the expenses required for the day-to-day operations like training expenses, rents, legal and professional charges, travel and conveyance charges, depreciation, interest and bank charges, for the evaluation purpose, the net operating expenses are taken into consideration.

1. Number of DMUs = 11
2. Inputs = Commission expenses (x1); Operating expenses (x2)
3. Output = Net Premiums earned (y)

All the variables for each DMUs are collected and arranged according to the requirement of the DEA analysis. To run the analysis accurately, the negative values had to be eliminated; therefore, a constant is added to all the values of the commission expenses.

Data Collection

A balanced panel data set of Indian general insurers is used for the study, covering the period 2014-2024. Using a balanced panel data set does not allow the insertion of insurers to the data set, if they enter or quit the market during the sample period. Therefore, a panel data set of the general insurers for the ten years is taken for the study that was continually in operation for the sample period. The data required for this study are extracted from the IRDA's annual reports and the insurers' annual financial reports. The monetary variables taken for the study are expressed in thousands of Indian rupees. The sample includes 11 general insurers operating in India with diversified businesses (health, fire, marine, motor, crop, and miscellaneous insurance products), including both private and public. The insurers selected for the study have a considerable market share in the Indian general insurance market.

RESULTS AND DISCUSSION

The efficiency scores are calculated using the software package DEAP version 2.1 given by Tim Coelli.

Table 1 presents the efficiency scores calculated by the Malmquist index for the overall observation period.

Table 1: Malmquist index summary of annual means

year	effch	pech	sech
2	1.159	1.004	1.155
3	1.324	1.099	1.205
4	1.150	1.024	1.122
5	0.958	0.978	0.980
6	0.476	0.785	0.067
7	1.255	1.088	1.154
8	2.094	1.321	1.584
9	1.036	1.005	1.031
10	0.517	0.822	0.630
mean	1.014	1.003	1.011

Notes: Number of firms (n) = 11; effch, technical efficiency change; pech, pure technical efficiency change; sech, scale efficiency change

An index value larger than one or less than one denotes progression and regression, respectively. According to the index, the observed mean of technical efficiency change (geometric mean) for the complete observation period is 1.014, meaning most insurers have seen 10.14% increase in efficiency due to innovation in technology. The insurers have observed improvement in efficiency in all the years except 2021-22, 2022-23 and 2023-24. However, the observed mean for pure technical efficiency is 1.003. If compare of pure technical efficiency scores year by year, the insurance sector has experienced significant

progress in most of the years except 2017-18, 2018-19 and 2023-24. The observed mean of the scale efficiency scores for the study period is 1.011.

Table 2 presents the efficiency scores of the sampled insurers for the overall observation period calculated by the Malmquist index.

Table 2: Malmquist index summary of firm means

Firm	effch	pech	sech	CE
1	1.166	1.028	1.134	1.166
2	0.904	0.959	0.942	0.903
3	0.967	0.989	0.978	0.967
4	0.902	0.950	0.949	0.902
5	1.066	1.100	0.969	1.066
6	1.515	1.081	1.403	1.516
7	0.988	0.985	1.003	0.988
8	0.936	1.000	0.936	0.936
9	0.918	0.965	0.952	0.919
10	0.926	0.990	0.935	0.926
11	1.000	1.000	1.000	1.000
mean	1.014	1.003	1.011	

Notes: Number of firms (n) = 11; effch, technical efficiency change; pech, pure technical efficiency change; sech, scale efficiency change; CE, cost efficiency

The mean value of the technical efficiency of the general insurers for the observation period is 1.014. It indicates the efficient performance of the general insurance sector for the observation period. The pure technical efficiency scores fall between 0.950 to 1.000. It indicates that the insurers use the most suitable and innovative technology to procure of the business. The average scale efficiency score for the overall observation period is 1.11, which means the insurance firms are achieving constant returns to scale. The cost efficiency is calculated using two components, pure technical efficiency and scale efficiency.

To establish the linkage between the IT investments of the insurers and cost efficiency scores, the net block of software (intangible assets) and the net value of IT equipment is taken for computation. The average amount invested by the insurers during the observation period shows a negative correlation with the cost efficiency scores of each firm, with the r value of .304 with a significance value of .363, which is more than 0.05. Hence, it signifies no significant relationship between the cost efficiency scores of the Indian general insurers and IT investments during 2014-15 to 2023-24. However, there is gradual increase in software and IT equipment by the insurers to adapt to the digitalized world.

CONCLUSION

As per the reports provided by IRDA, despite the availability of diversified products in the general insurance sector, the insurance penetration is comparatively low in the general insurance sector instead of the life insurance sector. The results obtained by this study do not show a clear linkage or relationship between the efficiency of the insurers and the investments in software and IT equipment. Although, the negative relationship between the two variables can be justified by two arguments: 1. selected insurers can adopt different strategies to manage their investments in IT and software, and IT work practices; 2. Investment in IT and software involve a huge amount of resources but can be fruitful in the long-run, not immediately. Information and communication technology implementation can create new possibilities for the insurance industry's growth. The insurers can deploy various innovative technologies to make the business processes more efficient.

SUGGESTIONS

It is advisable for insurers to strategically plan their IT expenditure as it involves huge monetary resources and devise strategies to brilliantly manage the IT investments to get the most out of the resources employed. The emergence of Industry 4.0 has increased the interdependency of the insurance industry on digital technologies; hence, it is insurance companies must develop an integrated strategic approach towards implementing digital technologies.

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