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Assessing Claim Settlement Dynamics in Indian Life Insurance with specific reference to LIC of India using Time Series and DEA

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Abstract
Claim settlement is an essential aspect of life insurance, highly influencing an insurer's public perception, efficiency, and credibility. This report analyses the claim settlement practices of the Life Insurance Corporation of India (LIC), the nation's oldest insurance company, from 2006-07 to 2023-24. LIC has maintained a strong position in claim settlement, irrespective of the market liberalization and competition from technologically advanced private players. The research analyses key performance indicators, including the claim settlement ratio (CSR), claim repudiation ratio, claim pending ratio, and unclaimed claim ratio, using data from the Insurance Regulatory and Development Authority of India (IRDAI) and Life Insurance Corporation (LIC) of India Annual Reports. Time Series Regression and Mann-Kendall trend tests were used to identify significant temporal trends in the Claim Settlement Ratio and the Value of Claims Settled. Results indicate that LIC has continually achieved a high CSR, reaching 98.74% in FY 2021-22, despite rising mortality claims due to COVID-19. Both the time series regression (p-value = 0.0009) and Mann-Kendall trend test (Z-value = 3.18, p-value = 0.00146, Kendall's Tau (τ) $\approx$ 0.556) reveal a statistically significant upward trend in LIC's Claim Settlement Ratio throughout the study period, indicating improving operational efficiency and customer service strategies. Additionally, Regression analysis has been conducted to provide an actual knowledge of how the quantum of claims settled and the rate of claim rejections affect the inflow of premium revenue. An output-oriented Malmquist DEA model was applied using DEAP software with Claim Settlement Ratio, Claim Rejected Ratio, Claim Unclaimed Ratio, and Claim Pending Ratio as inputs, and Net Premium Income as the output. This method determined the most efficient year within the study period by evaluating changes in technical efficiency and productivity over time. This analysis underscores LIC's commitment to fulfilling its contractual obligations, reinforcing policyholder trust, and its institutional credibility within the Indian insurance landscape.

Keywords:
Claim Settlement, Life Insurance Corporation of India (LIC), Malmquist DEA, Regression Analysis, Insurance Efficiency, Mann-Kendall Trend Test

Introduction
Claim settlement is the agreement of the contractual duties between an insurer and the insured, where the insurance company compensates the beneficiary for a valid claim under the terms of the policy. Claim settlement is not just an administrative task; rather, it is an important part in defining credibility, efficiency, & public perception of an insurance provider (Sahoo & Das, 2020). For policyholders, particularly in developing countries like India, a life insurer can honor claims swiftly and justly, representing the insurance product's true value (Mishra & Mishra, 2021).

LIC, with a huge customer base & an extensive branch network, has successfully made a historical record in claim settlement. In the financial year 2021-22, LIC disclosed a claim settlement ratio of 98.74%, the highest in the industry (IRDAI, 2022). With the high consistency ratio, the company demonstrates operational efficiency as well as its dedication to meet the expectations of millions of policyholders across the country (Kumar & Singh, 2019; Bhatnagar & Mehta, 2022). An efficient claim settlement process not only improves customer satisfaction but also minimizes the likelihood of litigation or grievance escalation, and thus contributes to the insurer's overall financial performance (Mishra & Mishra, 2021).
Amendments in IRDAI's regulations also impact the claim settlement process. IRDAI says that claims cannot be repudiated after three years from the policy's inception, regardless of misrepresentation, unless fraud is proven (IRDAI, 2023). This regulation enhances policyholder safety and forces insurers to refine risk assessment.

Literature Review

A comprehensive study has examined the claim settlement practices of LIC of India, highlighting its strategic position in the Indian insurance sector. Maheswari and Indirajit (2017) emphasized that LIC's reliable and timely claim settlements enhance confidence and increase net premium income. Yadav and Mohania (2015) compared LIC's claim settlement processing with ICICI Prudential and noted LIC's efficiency while highlighting the latter's superior transparency and customer communication. Narayana Gowd (2017) identified LIC as superior to private insurers in both operating efficiency and profitability due to its effective claim settlement system, while Rajesh and Yadav (2014) acknowledged LIC's enduring market leadership to its proficient claim resolution mechanisms. Kumar and Priyan (2012) further demonstrated through time series analysis that timely claim processing significantly improves to policy retention and revenue growth.

Recent trend analyses using the Mann-Kendall test validated a statistically significant increase in LIC's Claim Settlement Ratio (CSR) from 2006-07 to 2023-24, confirming the upward trend. Productivity analysis using Data Envelopment Analysis (DEA) and Malmquist indices by Banerjea (2021) and Narayana Gowd (2017) indicated that LIC's technical efficiency improved after regulatory reforms. Joy et al. (2022) examined that more than 87% of LIC nominees were satisfied with processes such as KYC updates, document submission, and money transfers.

In Nigeria, Oluwaleye and Ekiti (2021) discovered that effective claims management significantly impacts profitability via net loss and expense ratios. Hussanie and Joo (2019) used panel data to ascertain liquidity, investment performance, and premium growth as main profitability drivers among insurers of India. Ramanchi (2019) proved the role of capital allocation in profit maximization through regression analysis.

Yadav (2014) correlated LIC's effective claim processing with increased policy sales and premium inflows. Kaur Bawa and Chattha (2013) examined financial ratios and found LIC outperformed many private players in terms of solvency and leverage, with regression analysis indicating a positive relationship between profitability, liquidity, and size. During the pandemic, Banerjea and Biswas (2021) recorded LIC's adaptive strategies, including simplified claim documentation, which helped rapid resolution processing despite increased death claims. Lastly, actuarial analysis by Yin et al. (2020) and Shi and Zhao (2019), although not particular to LIC, shows that advanced models like copula-based regression can further enhance predictive precision in claim settlement predictions.

Objective Of The Study

1. To analyse different ratios like claim settlement ratio, claim repudiated ratio, unclaimed claim ratio, claim pending ratio during the research period.
2. To study the monotonic trend of claim settlement ratio & the value of claims resolved by LIC of India over the research period.
3. To examine the relationship between claim paid and claim repudiated on the net premium income of LIC of India.
4. To evaluate the most efficient year using DEA analysis taking claim settlement ratio & claim repudiated ratio as input and net premium income as output.

Research Methodology

India's contemporary insurance sector has many life insurers, but LIC of India has been chosen as a sample. The research employs a quantitative research approach to analyse the claim settlement performance of the Life Insurance Corporation of India (LIC) across 18 financial years, from 2006-07 to 2023-24. The primary data source for this analysis is the Annual Reports issued by the Insurance Regulatory and Development Authority of India (IRDAI), which provide extensive information on India's insurance sector.

Key performance indicators examined include:
Claim Settlement Ratio: The proportion of claims resolved relative to the total claims submitted. This is defined as the most prominent measure of insurer reliability.
Claim Repudiation Ratio: The proportion of claims rejected by LIC of India as compared to total claims submitted.
Claim Pending Ratio: The proportion of claims that remain unresolved at the end of a fiscal year.
Unclaimed Claim Ratio: Claims that remain unpaid due to different factors such as outdated designee details, lack of claimant identification, or beneficiary unawareness.
Value of Claims Settled: The total monetary value of claims settled by LIC.

To identify significant temporal patterns and monotonic trends, two primary statistical methods were used; Time Series Regression using EViews 12, and Mann-Kendall Trend Test using OriginPro 2025. To examine the association between claim paid and claim repudiated with net premium income of LIC of India, the researcher used Ordinary Least Squares (OLS) Regression using EViews 12. Lastly, Data Envelopment Analysis (DEA) using DEAP software has been used, taking claim settlement ratio & claim repudiated ratio as input and net premium income as output to assess the most efficient year.

Hypotheses Of The Study

$H_0$1: There is no significant change in the claim settlement ratio of LIC of India during the research period.
$H_0$2: There is no significant change in the value of claims settled by LIC of India during the research period.
$H_0$3: There is no significant association between the independent variables (Center Claim Paid, Square Claim Paid, Center Claim Repudiated, Square Claim Repudiated) and Net Premium Income.

- $H_0$3a: The coefficient for Center Claim Paid is zero (no linear relationship with Net Premium Income).
- $H_0$3b: The coefficient for Square Claim Paid is zero (no quadratic relationship with Net Premium Income).
- $H_0$3c: The coefficient for Center Claim Repudiated is zero.
- $H_0$3d: The coefficient for Square Claim Repudiated is zero.

$H_0$4: There is no significant change in Factor Productivity (TFPch) for LIC of India over the observed period, meaning that any observed productivity changes are not statistically different from 1 (no change), and are not primarily driven by technological change.

- $H_0$4a: The firm consistently operates at the efficiency frontier (Effch = 1.000) under variable returns to scale (VRS) assumptions, and there are no significant changes in efficiency over time.
- $H_0$4b: Technological change (Techch) does not significantly contribute to Total Factor Productivity change (TFPch) over the period.

Results And Discussion

The analysis of LIC's claim settlement performance from 2006-07 to 2023-24, utilizing data from IRDAI Annual Reports, reveals consistent efficiency and significant positive trends.

Claim Settlement Ratio: The performance of LIC regarding claim settlement from 2006-07 to 2023-24 shows a constantly high degree of efficiency, as shown in **Table 1.1.** During the financial year 2021-22, LIC executed a strategic investment in digital transformation, established an automated claim workforce, and expanded customer service touchpoints, with a settlement ratio of 98.74% and ₹28,408.38 crore settled across 13,49,865 policies (IRDAI, 2022; LIC Annual Report, 2022). This is crucial since the second wave of COVID-19

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Table 1.1: Claim Paid Ratio of LIC of India during the period 2006-07 to 2023-24

Year	Claims due at the beginning of the year		Claims booked during the year		Total claims during the year				Claim (Paid)			
	Policies (in No.)	Amount (₹ in Crore)	Policies (in No.)	Amount (₹ in Crore)	Policies (in No.)	Total Claim %	Amount (₹ in Crore)	Total Claim %	Policies (in No.)	Claim Settlement Ratio	Amount (₹ in Crore)	Results in %
2006-07	9574	185.39	602425	4404.03	611999	**100%**	4589.42	**100%**	593250	**96.94%**	4289.28	**93.46%**
2007-08	9982	205.43	539779	3976.80	549761	**100%**	4182.23	**100%**	531653	**96.71%**	3918.72	**93.70%**
2008-09	11550	141.37	579547	4302.80	591097	**100%**	4444.17	**100%**	564389	**95.48%**	4165.10	**93.72%**
2009-10	13076	148.53	664298	4900.90	677374	**100%**	5049.43	**100%**	653909	**96.54%**	4799.55	**95.05%**
2010-11	9527	118.45	729975	6308.96	739502	**100%**	6427.41	**100%**	717529	**97.03%**	6093.14	**94.80%**
2011-12	10803	177.32	720533	6696.21	731336	**100%**	6873.53	**100%**	712501	**97.42%**	6559.51	**95.43%**
2012-13	8856	171.34	741720	7379.53	750576	**100%**	7550.87	**100%**	733545	**97.73%**	7222.90	**95.66%**
2013-14	7829	254.65	752505	8650.39	760334	**100%**	8905.04	**100%**	746212	**98.14%**	8475.26	**95.17%**
2014-15	3962	227.69	751939	9252.80	755901	**100%**	9480.49	**100%**	742243	**98.19%**	9055.18	**95.51%**
2015-16	3652	207.63	758331	9929.46	761983	**100%**	10137.09	**100%**	749249	**98.33%**	9690.17	**95.59%**
2016-17	3914	242.71	765472	10815.89	769386	**100%**	11058.60	**100%**	756399	**98.31%**	10585.53	**95.72%**
2017-18	3203	195.06	735879	11184.34	739082	**100%**	11379.40	**100%**	724596	**98.04%**	10747.53	**94.45%**
2018-19	569	90.28	750381	13412.92	750950	**100%**	13503.20	**100%**	734328	**97.79%**	12871.92	**95.32%**
2019-20	791	135.92	758125	13558.42	758916	**100%**	13694.34	**100%**	733809	**96.69%**	12797.85	**93.45%**
2020-21	5875	349.69	941101	18755.65	946976	**100%**	19105.34	**100%**	933889	**98.62%**	18295.58	**95.76%**
2021-22	1725	292.42	1365379	29293.46	1367104	**100%**	29585.88	**100%**	1349865	**98.74%**	28408.38	**96.02%**
2022-23	2282	360.15	919925	18967.48	922207	**100%**	19327.63	**100%**	908576	**98.52%**	18397.77	**95.19%**
2023-24	675	305.87	844312	18461.21	844987	**100%**	18767.08	**100%**	829318	**98.15%**	17861.76	**95.18%**

(Source: Author's analysis from IRDAI's Annual Report)

significantly increased mortality-related claims. However, in the year 2008-09, LIC reflects a minimal settlement ratio of 95.48% and ₹4165.10 crore settled across 564389 policies, because of the pre-digital era's lack of digitalization, dependence on manual processing and documentation delay (IRDAI, 2009).

Claim Repudiated Ratio: From 2006-07 to 2023-24, LIC of India's claim repudiation performance reflects a trend toward improving operational integrity and customer-centric claim settlements as shown in **Table 1.2.** The most efficient year in terms of repudiation was 2017-18, recording the lowest repudiation ratio of 0.67%, indicating enhanced claim verification, better documentation by policyholders, and efficient internal workflows (IRDAI, 2018). In contrast, 2023-24 marked the least efficient year, with the highest repudiation ratio of 1.76% and a rejection benefit amount of ₹517.5 crore. This spike can be attributed to stricter regulatory scrutiny, enhanced fraud detection systems, and more rigorous claim documentation protocols introduced in the post-COVID-19 phase, aiming to curb misrepresentation and irregularities (IRDAI, 2024; RBI, 2023).

Claim Unclaimed Ratio: Regarding unclaimed claims, LIC demonstrated consistent efficiency across several years. The most efficient years were 2007-08, 2011-12, and 2023-24, each recording an unclaimed claim ratio of only 0.06% as shown in **Table 1.2.** These low figures reflect the insurer's success in beneficiary tracking, timely intimation, and policyholder awareness efforts (IRDAI, 2008; 2012; 2024). Effective digital communication, integrated beneficiary databases, and public outreach campaigns have played a critical role in minimizing unclaimed settlements. While 2023-24 saw a spike in repudiations, its continued excellence in minimizing unclaimed claims underscores LIC's dual focus on compliance and outreach.

Claim Pending Ratio: Between 2006-07 and 2023-24, 2023-24 was the most efficient year, with a claim pending ratio of just 0.03% as shown in **Table 1.3**, and no cases pending beyond six months, reflecting enhanced digital infrastructure, streamlined underwriting, and real-time claim tracking (IRDAI, 2024). In contrast, 2008-09 was the least efficient, showing a high pending ratio of 2.21%, with nearly 38% of claims pending for over six months. Contributing factors included manual processes, limited tech integration, and administrative bottlenecks (Rai & Sirohi, 2011). Over time, regulatory reforms and LIC's tech-driven upgrades have significantly reduced delays in claim settlement.

The Unclaimed Claim Ratio is an essential indicator that evaluates an insurer's operational efficiency, policyholder awareness, and communication effectiveness. It denotes the ratio of claims that remain unsettled for various reasons, specifically, policyholders or beneficiaries failing to claim their benefits. LIC of India has consistently shown a low unclaimed claim ratio. It has three distinct characteristics: low fluctuations, absence of a strong trend, and a stable low ratio.

Unclaimed claims are a substantial financial loss for beneficiaries who are not aware of the policy's existence or the claim procedure. A large unclaimed claims ratio reduces public trust in insurance companies. The process of confirming entitlement may be difficult and lengthy for beneficiaries who identify an unclaimed insurance.

Insurers such as LIC must reveal and control unclaimed funds, often transferring them to designated accounts like the Senior Citizens' Welfare Fund in India after a certain duration of

unclaimed claims. A substantial amount of unclaimed funds can attract high regulatory examination and possible penalties. The management of unclaimed policies generates administrative expenses for the insurer, affecting its obligations and financial strategy.

Various factors lead to unclaimed claims, including inadequate information about the policy's existence, misplacement of policy documents, changes in family circumstances, and absence of clear nomination. Beneficiaries may have difficulties in providing requisite documents, and the claims filing procedure can be depressing during sad moments.

LIC consistently strives to reduce unclaimed funds through different strategies such as digital outreach, streamlined claim forms, public awareness campaigns, and proactive beneficiary tracking.

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Table 1.2: Claim Repudiated Ratio & Claim Unclaimed Ratio of LIC of India during the period 2006-07 to 2023-24

Year	Claims due at the beginning of the year		Claims booked during the year		Claims (Repudiated/Rejected)				Claims (Unclaimed)			
	Policies (in No.)	Amount (₹ in Crore)	Policies (in No.)	Amount (₹ in Crore)	Policies (in No.)	Claim Repudiated Ratio	Amount (₹ in Crore)	Results in %	Policies (in No.)	Claim Unclaimed Ratio	Amount (₹ in Crore)	Results in %
2006-07	9574	185.39	602425	4404.03	8767	**1.43%**	94.71	**2.06%**	0	**0%**	0	**0%**
2007-08	9982	205.43	539779	3976.80	6223	**1.13%**	90.54	**2.16%**	335	**0.06%**	31.60	**0.76%**
2008-09	11550	141.37	579547	4302.80	7846	**1.33%**	72.45	**1.63%**	5786	**0.98%**	58.09	**1.31%**
2009-10	13076	148.53	664298	4900.90	8227	**1.21%**	80.36	**1.59%**	5711	**0.84%**	51.07	**1.01%**
2010-11	9527	118.45	729975	6308.96	7384	**1.00%**	109.41	**1.70%**	3786	**0.51%**	47.54	**0.74%**
2011-12	10803	177.32	720533	6696.21	9530	**1.30%**	137.96	**2.01%**	449	**0.06%**	4.72	**0.07%**
2012-13	8856	171.34	741720	7379.53	8440	**1.12%**	161.68	**2.14%**	762	**0.10%**	18.04	**0.24%**
2013-14	7829	254.65	752505	8650.39	8387	**1.10%**	181.30	**2.04%**	1773	**0.23%**	20.79	**0.23%**
2014-15	3962	227.69	751939	9252.80	8689	**1.15%**	194.93	**1.15%**	1317	**0.17%**	22.75	**0.24%**
2015-16	3652	207.63	758331	9929.46	7502	**0.98%**	183.18	**1.80%**	1318	**0.17%**	21.03	**0.21%**
2016-17	3914	242.71	765472	10815.89	7432	**0.97%**	202.35	**1.83%**	2352	**0.31%**	75.66	**0.68%**
2017-18	3203	195.06	735879	11184.34	4958	**0.67%**	194.73	**1.71%**	8959	**1.21%**	346.86	**3.05%**
2018-19	569	90.28	750381	13412.92	6641	**0.89%**	201.54	**1.49%**	9190	**1.22%**	293.82	**2.18%**
2019-20	791	135.92	758125	13558.42	8296	**1.10%**	207.1	**1.52%**	10936	**1.44%**	339.70	**2.48%**
2020-21	5875	349.69	941101	18755.65	9465	**1.00%**	280.85	**1.47%**	1897	**0.20%**	236.49	**1.24%**
2021-22	1725	292.42	1365379	29293.46	12332	**0.90%**	1197.19	**1.20%**	2625	**0.19%**	461.66	**1.56%**
2022-23	2282	360.15	919925	18967.48	12329	**1.34%**	431.67	**2.23%**	627	**0.07%**	192.32	**1.00%**
2023-24	675	305.87	844312	18461.21	14864	**1.76%**	517.5	**2.76%**	530	**0.06%**	43.77	**0.23%**

(Source: Author's analysis from IRDAI's Annual Report)

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Table 1.3: Claim Pending Ratio of LIC of India during the period 2006-07 to 2023-24

Year	Claims booked during the year		Claims due at the end of the year				Split up of Claims due time-wise (Lives)								
	Policies (in No.)	Amount (₹ in Crore)	Policies (in No.)	Claim Pending Ratio	Amount (₹ in Crore)	Results in %	< 3 months	Results in %	3 - < 6 months	Results in %	6 - < 1 yr	Results in %	> 1 yr	Results in %	Total
2006-07	602425	4404.03	9982	**1.63%**	205.43	**4.48%**	3179	**31.85**	2795	**28.00**	2375	**23.79**	1633	**16.36**	9982
2007-08	539779	3976.80	11550	**2.10%**	141.37	**3.38%**	5054	**43.76**	2911	**25.20**	2186	**18.93**	1399	**12.11**	11550
2008-09	579547	4302.80	13076	**2.21%**	148.53	**3.34%**	5460	**41.76**	2828	**21.63**	2528	**19.33**	2260	**17.28**	13076
2009-10	664298	4900.90	9527	**1.41%**	118.45	**2.35%**	3501	**36.75**	2282	**23.95**	2148	**22.55**	1596	**16.75**	9527
2010-11	729975	6308.96	10803	**1.46%**	177.32	**2.76%**	3954	**36.60**	2716	**25.14**	2685	**24.85**	1448	**13.40**	10803
2011-12	720533	6696.21	8856	**1.21%**	171.34	**2.49%**	3309	**37.36**	2087	**23.57**	1957	**22.10**	1503	**16.97**	8856
2012-13	741720	7379.53	7829	**1.04%**	148.25	**1.96%**	3136	**40.06**	1211	**15.47**	1650	**21.08**	1832	**23.40**	7829
2013-14	752505	8650.39	3962	**0.52%**	227.69	**2.56%**	681	**17.19**	561	**14.16**	1290	**32.56**	1430	**36.09**	3962
2014-15	751939	9252.80	3652	**0.48%**	208.00	**2.19%**	679	**18.59**	723	**19.80**	1151	**31.52**	1099	**30.09**	3652
2015-16	758331	9929.46	3914	**0.51%**	243.00	**2.39%**	693	**17.71**	796	**20.34**	1441	**36.82**	984	**25.14**	3914
2016-17	765472	10815.89	3203	**0.42%**	195.06	**1.76%**	2786	**86.98**	310	**9.68**	62	**1.94**	45	**1.40**	3203
2017-18	735879	11184.34	569	**0.08%**	90.29	**0.79%**	257	**45.17**	254	**44.64**	20	**3.51**	38	**6.68**	569
2018-19	750381	13412.92	791	**0.11%**	135.92	**1.01%**	370	**46.78**	285	**36.03**	47	**5.94**	89	**11.25**	791
2019-20	758125	13558.42	5875	**0.77%**	349.69	**2.55%**	3144	**53.51**	2731	**46.49**	0	**0.00**	0	**0.00**	5875
2020-21	941101	18755.65	1725	**0.18%**	292.42	**1.53%**	792	**45.91**	933	**54.09**	0	**0.00**	0	**0.00**	1725
2021-22	1365379	29293.46	2282	**0.17%**	360.15	**1.22%**	1211	**53.07**	1071	**46.93**	0	**0.00**	0	**0.00**	2281
2022-23	919925	18967.48	675	**0.07%**	305.87	**1.58%**	655	**97.04**	20	**2.96**	0	**0.00**	0	**0.00**	675
2023-24	844312	18461.21	275	**0.03%**	344.05	**1.83%**	198	**72.00**	77	**28.00**	0	**0.00**	0	**0.00**	275

(Source: Author's analysis from IRDAI's Annual Report)

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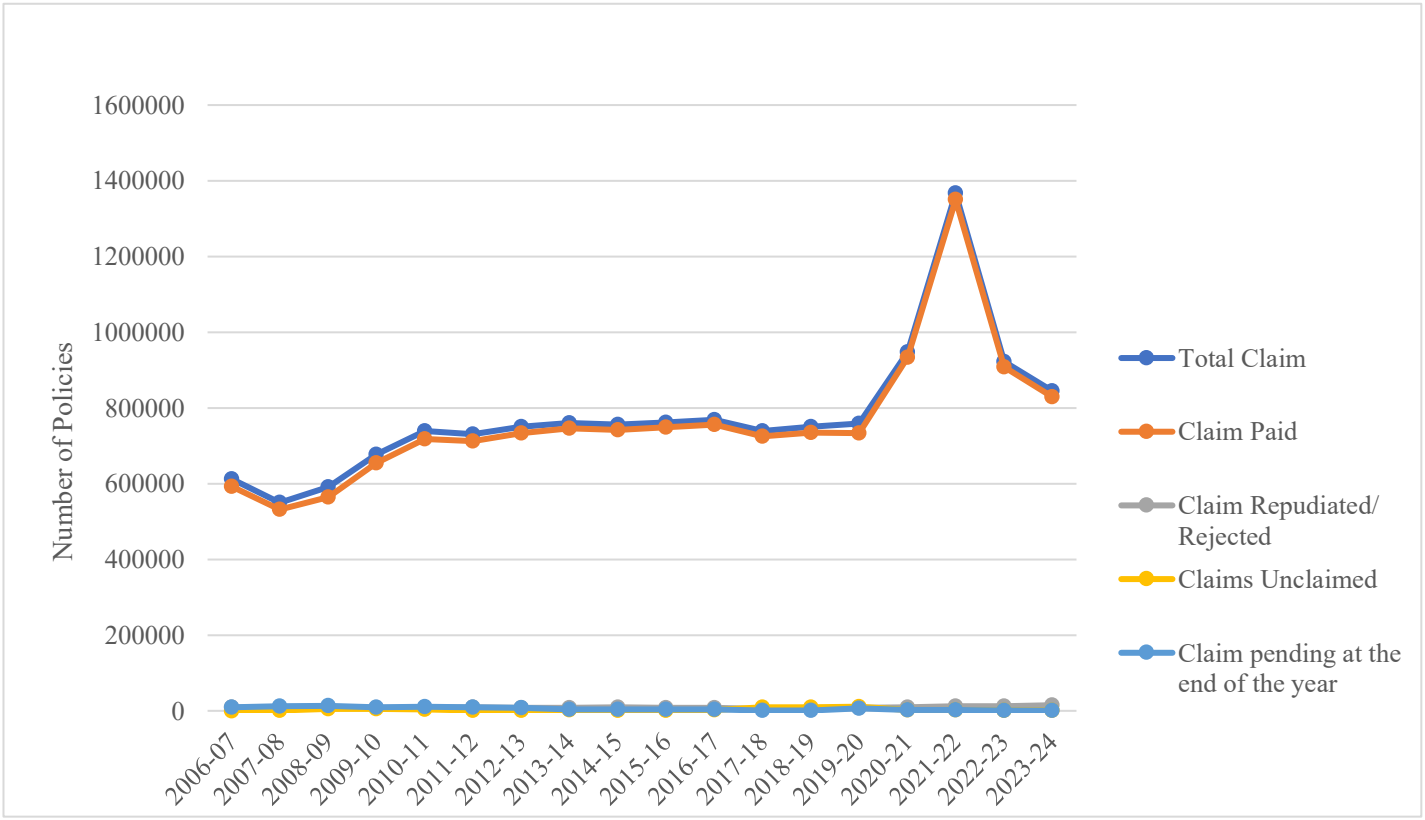
Figure 1.1: No. of Policies paid, repudiated, unclaimed, or due during the period 2006-07 to 2023-24



(Source: Author's Analysis from MS Excel)

Fig. 1.1 reflects the trend of different categories of insurance claims i.e., claim paid, claim repudiated/ rejected, claim unclaimed & claim due during year end from 2006-07 to 2023-24. The data reflects a positive correlation between total claims and claims paid, indicating that LIC of India has consistently settled the majority of claims. From 2006-07 to 2019-20, total claim and claims paid shows a gradual and steady increase. A notable spike in both total claims and claims paid occurred in 2021-22, which is due to the second wave of COVID-19, which began in March 2021 and peaked during April-May 2021. This wave, driven by the highly transmissible Delta variant, caused an exponential surge in infections and fatalities, severely overwhelming healthcare infrastructure (World Health Organization, 2021), which substantial rise in the insurance mortality claims during the period. Both metrics decline in 2022-23 and 2023-24, but remain higher than the pre-pandemic year. Claim repudiated/ rejected remains low and stable throughout the period, indicating that claim rejection rates are minimal and consistent. Number of claim unclaimed are very low across all the years, showing that most claimants are aware and active in claiming their dues. Numbers of claim due during year end also remains low, reflecting efficient and timely claim settlement. There was no abnormal rise even in 2021-22, implying LIC managed the high volume efficiently.

Figure 1.2: No. of Claims Pending duration wise during the year

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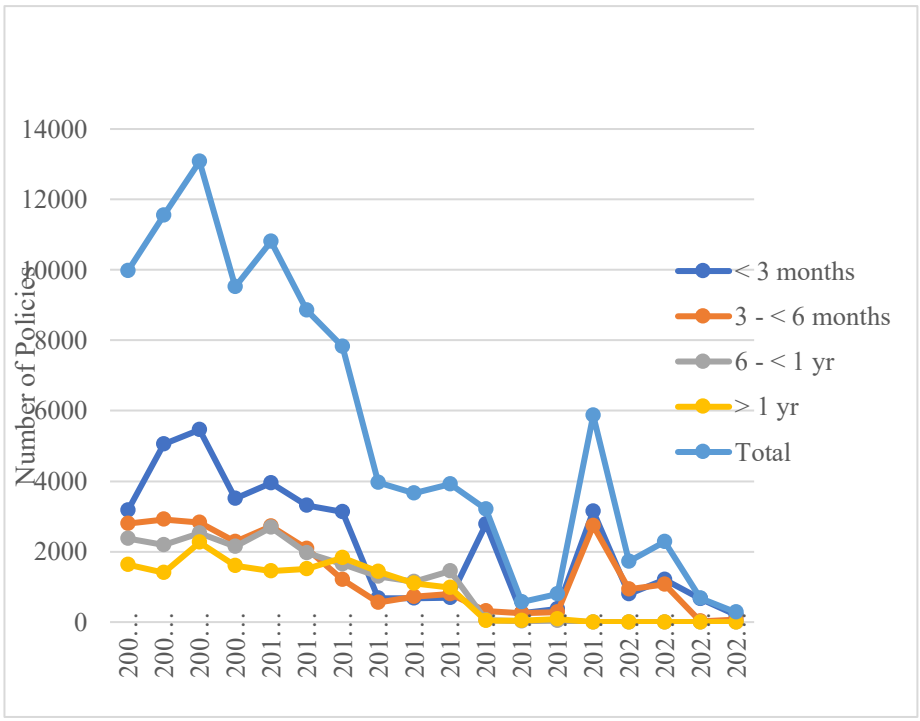
2006-07 to 2023-24



(Source: Author's Analysis from MS Excel)

Figure 1.2 shows the duration of time taken to settle the pending claim during the period 2006-07 to 2023-24 with the help of a line chart, indicating a notable improvement in operational efficiency over time. In the initial years, a significant number of claims were delayed between 2007-08 to 2011-12, with the highest concentration falling under less than 3 months. This period saw the total number of delayed claims peaking at over 13000, particularly in 2008-09, which reflects the administrative backlog and procedural lags prevalent in the public sector insurers during that era (IRDAI, 2011). Post 2012-13, a steady decline in delayed settlements is observed with marked reductions across all duration categories, especially those exceeding 6 months. The introduction of digital workflows, centralized claim processing, and policyholder-friendly reforms by LIC and IRDAI has contributed to this trend (IRDAI, 2014; LIC Annual Report, 2015). Claims due for more than one year became negligible after 2016-17, signifying a structural shift towards prompt claim redressal. During the COVID-19 pandemic, particularly in 2019-20 and 2020-21, a visible spike in claims processed within <3 months and 3-<6 months duration. This correlates with the heightened mortality rates and increased claim volumes during the first and second waves of COVID-19 (Ministry of Health and Family Welfare, 2021; World Health Organization, 202). By the end of 2023-24, data shows a sharp decline in delays, with the majority of claims settled within 3 months and very few falling into longer duration categories. This reflects LIC's enhanced settlement infrastructure, supported by regulatory pressure, technological upgradation and a stronger focus on customer service (IRDAI, 2022).

Time Series Regression and Mann-Kendall Trend Test

A robust statistical framework is provided by time series regression to model and interpret such changes over time, facilitating both trend detection and forecasting (Gujarati & Porter, 2009). In addition, the "Mann-Kendall Trend test", a widely accepted non-parametric method, is suitable for the identification of monotonic trends in time-series data without any assumptions

of specific distribution (Kendall, 1975; Yue, Pilon, & Cavadias, 2002). This makes it suitable for LIC, where claim settlement behavior may be affected by exogenous disruptions such as pandemics, economic reforms, or digitization initiatives. These analytical tools provide a rigorous and interpretable method for assessing the evolution of LIC's claim settlement efficiency over time, offering for management and public policy stakeholders with actionable insights.

To measure the strength and direction of the trend, the **Kendall's Tau (τ)** coefficient was calculated, in addition to the Mann–Kendall statistic (S). Kendall (1938) first introduced "Kendall's Tau", a non-parametric correlation measure calculated using data rank rather than their actual values. This makes it appropriate for time-series trend analysis where linearity or normal distribution cannot be presumed. A strong positive trend is indicated by Tau values that are closer to +1, which range between -1 and +1. In order to identify trends, this method has been widely adopted in environmental, financial, and insurance datasets (Kendall, 1975; Yue, Pilon, & Cavadias, 2002).

Figure 1.3: Time Series Regression of Claim Settlement Ratio

Variables	Coefficient	Std. Error	t-Statistics	Prob.
C	0.966254	0.002914	331.6470	0.0000
@TREND	0.001184	0.000293	4.046178	0.0009
R-squared	0.505739	F-statistic		16.37156
Adjusted R-squared	0.474848	Prob(F-statistic)		0.000937

(Source: Compiled by the Author from EViews 12)

The trend in LIC's Claim Settlement Ratio over 18 years period from 2006–07 to 2023–24 was assessed using a time series regression as shown in **Fig. 1.3**. Claim Settlement Ratio was the dependent variable, and time was the independent variable, which was represented using EViews' @TREND function. The regression results suggest a statistically significant and positive trend in the Claim Settlement Ratio. Particularly, the coefficient of @TREND is 0.001184 with a p-value of 0.0009, that is less than the standard level of significance 0.05. This means on average, LIC's Claim Settlement Ratio has increased by approximately 0.1184% per year during the study period. The time trend makes about 50.57% of the variation in the Claim Settlement Ratio, as reflected by the R-squared value of 0.5057. The F-statistic of 16.37 & a corresponding p-value of 0.000937 confirm that regression is statistically significant, affirming that the model consistently captures the upward trend in claim settlement performance over time.

Figure 1.4: Mann-Kendall Trend Test of Claim Settlement Ratio

Mann-Kendall Test (16-06-2025 23:46:47)

Test Statistics

	N	M-K Statistic	Standard Error	Z Value	Prob>|Z|	Alpha	Sig
B"Claim Settlement ratio"[1:18]	18	85	26.40076	3.18173	0.00146	0.05	1

Null Hypothesis: Data has no monotonic trend.
Alternative Hypothesis: Data has a monotonic upward or downward trend.
At the 0.05 level, input data has a significant upward trend.

(Sources: OriginPro 2025)

Mann-Kendall trend analysis was conducted on the Claim Settlement Ratio. It reflects the proportion of claims settled out of the total claims received. The result yielded a Mann–Kendall

statistic (S) of 85, a Z-value of 3.18, and a p-value of 0.00146 as illustrated in **Fig. 1.4**, showing a significant upward trend at the 5% level. The corresponding Kendall's Tau (τ) was computed as

$$\tau = \frac{S}{n(n-1)/2}$$

Where **τ** is approximately 0.556, suggesting a moderate to strong positive monotonic trend. LIC not only increased the volume of settled claims but also enhanced its claim settlement efficiency in relation to the total claims received. These results confirm that LIC's internal claim processing method and customer service strategies have positively evolved over the years, reinforcing trend-detection methods recommended in performance benchmarking literature (Yue, Pilon, & Cavadias, 2002).

Figure 1.5: Time Series Regression of Value of Claim Settled

Variables	Coefficient	Std. Error	t-Statistics	Prob.
C	1662.287	1411.492	1.177681	0.2561
@TREND	1073.947	141.7410	7.576830	0.0000
R-squared	0.782041	F-statistic		57.40836
Adjusted R-squared	0.768419	Prob(F-statistic)		0.000001

(Source: Compiled by the Author from EViews 12)

A time series regression analysis was conducted to evaluate the trend in the Value of Claims Settled (in Crore) by LIC over the period 2006-07 to 2023-24 as illustrated in **Fig. 1.5**. The regression used time as the independent variable, represented by the @TREND variable in EViews. The results indicate a statistically significant and strong upward trend. The coefficient for @TREND is 1073.947, indicating that the value of claims settled increased by approximately ₹1073.95 crore per year during the study period. The method is highly significant and shows a meaningful trend with a P-value of 0.0000. It explains 78.2% of the variation in the value of claims settled is explained by the time trend with R-squared of 0.782. The F-statistic of 57.40386 and the associated p-value of 0.000001, indicate overall regression model is statistically significant. The results verify that the value of claims settled by LIC has been steadily increasing over the 18-year period.

Figure 1.6: Mann-Kendall Trend Test of Claim Settlement Ratio

Mann-Kendall Test (16-06-2025 23:43:17)

Test Statistics

	N	M-K Statistic	Standard Error	Z Value	Prob>|Z|	Alpha	Sig
B"Value of Claim Settlement"[1:18]	18	139	26.40076	5.22712	1.72168E-7	0.05	1

Null Hypothesis: Data has no monotonic trend.
Alternative Hypothesis: Data has a monotonic upward or downward trend.
At the 0.05 level, input data has a significant upward trend.

(Sources: OriginPro 2025)

Fig.1.6 illustrates that the Mann–Kendall trend test was conducted to examine the long-term trend in the Value of Claim Settlements by LIC of India over an 18-year period. The analysis gives a Mann-Kendall statistic (S) of 139, a Z-value of 5.23, and a p-value of 1.72×10^{-7}, which is highly significant at the 0.05 level. These results reject the null hypothesis. The data have no monotonic trend and confirm the existence of a statistically significant upward trend. The Kendall's Tau coefficient (τ), was calculated as

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$$\tau = \frac{S}{n(n-1)/2}$$

Where τ is approximately 0.908, which suggests LIC has a consistent and substantial rise in the monetary value of claims settled. The significant improvements in LIC's claims processing and financial disbursement performance are indicated by the rapid increase in both absolute values and statistical strength. The Mann-Kendall test is well-suited for such non-parametric time-series analysis, especially in public service institutions where performance adjustments are incremental and accumulative (Mann & Kendall, 1945; Kendall, 1975).

Regression Analysis using EViews 12

Regression analysis is an important statistical tool for assessing the financial dynamics of the Life Insurance Corporation of India (LIC), particularly emphasizing the relationship between net premium income and claims paid & claim repudiated/ rejected. LIC, a public sector insurer, manages a significant portion of India's life insurance market. LIC's financial stability depends on maintaining a balance between premium collection and settlement of claims (IRDAI, 2023). This methodological approach enables an empirical knowledge of how the quantum of claims settled and the rate of claim rejections influence the inflow of premium revenue. Moreover, such analysis helps in assessing LIC's effectiveness in claim management strategies, thereby providing valuable insights into optimization of financial performance and improvement of policyholder satisfaction (Gujarati & Porter, 2009; Wooldridge, 2016).

Figure 1.7: Multiple Linear Regression using Least Squares

Variables	Coefficient	Std. Error	t-Statistics	Prob.
C	70915.22	19453.92	3.645293	0.0024
Claim Paid	27.00453	3.013034	8.962572	0.0000
Claim Repudiated/Rejected	-315.0495	74.32443	-4.238842	0.0007
R-squared	0.913450	F-statistic		79.15523
Adjusted R-squared	0.901910	Prob(F-statistic)		0.000000
		Durbin-Watson stat		1.339460

(Source: Compiled by the Author from EViews 12)

Figure 1.7 assesses the impact of claims paid and claim repudiated/ rejected on net premium income. A multiple Linear Regression model was employed using the Ordinary Least Squares (OLS) in EViews 12. It estimates the relationship between one dependent variable, i.e., Net Premium Income, and multiple independent variables, i.e., Claims Paid & Claims repudiated/ rejected, by minimizing the sum of squared residuals. Variables were selected after a comprehensive examination of existing literature, which suggests that efficient claim settlement improves insurer credibility and influences premium income through increased policyholder trust and retention (Srivastava & Shukla, 2016; Kumari & Devi, 2020; Gujarati & Porter, 2009).

The variable total claims unsettled was intentionally excluded while constructing the regression model, due to its nature and implications in the financial reporting. Claims paid and claims repudiated/rejected have a direct and measurable impact on the cash flow and operational performance of the Life Insurance Corporation (LIC) of India. The total claims unsettled represent an outstanding liability, which has been reported to the insurer but remains pending due to ongoing verification, documentation, or procedural requirements. In the insurance

industry, claim liabilities are recognized in accordance with standard accounting practices. Claim liabilities are recognized based on incurred but not reported (IBNR) reserves and outstanding claims provisions, which reflect anticipated future obligations rather than current financial outflows.

The Regression equation is specified as:

$$Y= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon$$

Where:

Y = Dependent Variable (Net Premium Income)

β_0 = Intercept (Constant term)

$\beta_1, \beta_2, \ldots, \beta_k$ = Coefficients for each independent Variables

$X_1, X_2 \ldots, X_k$ = Independent Variables (Claims Paid, Claims Repudiated/Rejected)

ε = Error term (residual)

The model implies a positive relationship between Claims Paid and Net Premium Income, but it is not a direct causal relationship; paying more claims somehow increases income. The primary factor responsible for both increased premium income and increased claims paid is a "larger business scale". Business scale is a significant determinant of both Net Premium Income and Claims Paid. But it is not included as a variable in the model, then "business scale" becomes an omitted variable. Since "business scale" is correlated with Claims Paid and affects Net Premium Income, its effect is absorbed into the error term of the regression. This creates an association between the included independent variable (Claims Paid) and the error term, which represents omitted variable bias- a form of endogeneity.

A Durbin-Watson statistic significantly different from 2 can indicate autocorrelation. In this case, the value is 1.339 as shown in **Fig. 1.3**. The model assumes a linear relationship between the independent variables and Net Premium Income. In reality, the relationships might be more complex and non-linear. The analysis identified moderate multicollinearity between Claims Paid and Claims Repudiated/Rejected (VIF around 5.30). The model specification assumption appears to be violated, as indicated by the significant Ramsey RESET test.

Figure 1.8: Multiple Linear Regression using Least Squares after changing the units of the Independent Variables

Variables	Coefficient	Std. Error	t-Statistics	Prob.
C	-97593.20	86790.00	-1.124475	0.2785
Number of Policies Paid	0.345734	0.130571	2.647861	0.0183
Number of Policies Repudiated/Rejected	13.38992	9.812916	1.364520	0.1925
R-squared	0.572860	F-statistic		10.05863
Adjusted R-squared	0.515907	Prob(F-statistic)		0.001695
		Durbin-Watson stat		0.921750

(Source: Compiled by the Author from EViews 12)

Figure 1.8 examines the impact of number of policies paid and number of policies repudiated/ rejected on net premium income. A multiple Linear Regression model was conducted using the Ordinary Least Squares (OLS) in EViews 12. It estimates the relationship between one dependent variable, i.e., Net Premium Income, and multiple independent variables, i.e., number

of policies paid and number of policies repudiated/ rejected, by minimizing the sum of squared residuals.

Initially, the regression model in this study utilized monetary values (in rupees) for both the dependent and independent variables to analyze the financial efficiency and claim settlement performance of LIC of India as shown in **Fig. 1.3**. However, diagnostic tests revealed that the model suffered from violations of key regression assumptions. Specifically, Autocorrelation, Multicollinearity, Non-linearity and specification errors.

These violations necessitated a re-evaluation of the model structure and measurement methodology. Upon further analysis, it was decided to replace monetary-valued independent variables with volume-based operational indicators, primarily the number of policies.

This approach is aligned with existing literature, where operational performance in insurance was quantified using units such as claim counts or policy volumes, particularly when assessing efficiency and service outcomes rather than purely financial results (Outreville, 1996; Cummins & Weiss, 1998).

The analysis indicates that both independent variables have a positive influence on net premium income, with coefficients of 0.345734 and 13.38992, respectively. The R-squared value is 0.572860, confirming that approximately 57% of the change in net premium income is due to the independent variables. Overall model is statistically significant with F-statistic value of 10.05863 & p-value of 0.001695.

All fundamental assumptions, including normality of residuals, homoscedasticity, No Multicollinearity, and lack of autocorrelation, were satisfactorily met. However, the Ramsey RESET test indicates a possibility of non-linearity in the model specification.

Figure 1.9: Multiple Linear Regression using Least Squares after Squaring the Independent Variables

Variables	Coefficient	Std. Error	t-Statistics	Prob.
C	-322430.1	256791.0	-1.255613	0.2314
Number of Policies Paid	1.968454	0.465078	4.232528	0.0010
Square of Policies Paid	-8.48E-07	2.41E-07	-3.524477	0.0037
Number of Repudiated/Rejected	-89.28541	34.47625	-2.589766	0.0224
Square of Policies repudiated	0.004942	0.001690	2.923747	0.0119
R-squared	0.839345	F-statistic		16.97966
Adjusted R-squared	0.789912	Prob(F-statistic)		0.000044
		Durbin-Watson stat		1.100069

(Source: Compiled by the Author from EViews 12)

To further investigate the non-linearity, polynomial terms (squares of the independent variables) were included as shown in **Fig. 1.9**. Although this improved the RESET test results, where p-value = 0.0111 (F-test), and 0.0020 (Likelihood ratio test). It is showing that the squared terms are statistically significant. But it also reflects excessively high Variance Inflation Factors (greater than 40), indicating severe multicollinearity. The researcher applied "ridge regression" to mitigate multicollinearity, but it did not yield improvements.

Centered squares of the independent variables were used to overcome this issue. Centering implies subtracting the mean of each variable before squaring. It reduces the correlation between the linear and quadratic terms while preserving the interpretation of the non-linear relationship (Aiken & West, 1991). This technique helped reduce multicollinearity and allowed for a more stable estimation of polynomial effects.

Figure 1.10: Exploration of Non-Linearity and Mitigation of Multicollinearity using Centered Polynomial Terms

Variables	Coefficient	Std. Error	t-Statistics	Prob.
C	282061.7	16827.24	16.76221	0.0000
Center of Policies Paid	0.675637	0.124720	5.417225	0.0001
Center Square of Policies Paid	-8.48E-07	2.41E-07	-3.524477	0.0037
Center of Repudiated/Rejected	-2.905166	7.834395	-0.370822	0.7167
Center Square of Policies repudiated	0.004942	0.001690	2.923747	0.0119
R-squared	0.839345	F-statistic	16.97966	
Adjusted R-squared	0.789912	Prob(F-statistic)	0.000044	
		Durbin-Watson stat	1.100069	

(Source: Compiled by the Author from EViews 12)

The regression model examines the effect of claim-related factors on Net Premium Income (NPI) using centered and squared terms to address for non-linearity and multicollinearity as shown in **Fig. 1.10**. The model has a good fit with an R^2 of 0.839 (Adjusted R^2 = 0.790). It indicates that about 79% of the change in NPI is explained by the independent variables. The F-statistic is substantial (F = 16.98), validating the model's overall explanatory power.

Both centered claims paid (β = 0.676, *P* =0.0001) and, its square term (β = -8.48E-07, *P* = 0.0037) are statistically significant. It indicates the presence of a non-linear relationship, which is explicitly described by the polynomial regression method. The positive coefficient of the centered term suggests a direct correlation with NPI. However, the negative coefficient of the squared term implies declining returns at higher levels of claim payments. This corresponds with insurance theory, whereby excessive claims may diminish profitability or prompt pricing adjustments (Cummins & Weiss, 1998).

The centered claim repudiated is not statistically significant (*p* = 0.7167). However, its squared term is significant (β = 0.0049, *p* = 0.0119), indicating that only higher levels of repudiated claims have a quantifiable non-linear impact on NPI. This may indicate reputational or customer-retention challenges that become visible only when repudiations exceed a certain level (Outreville, 1996).

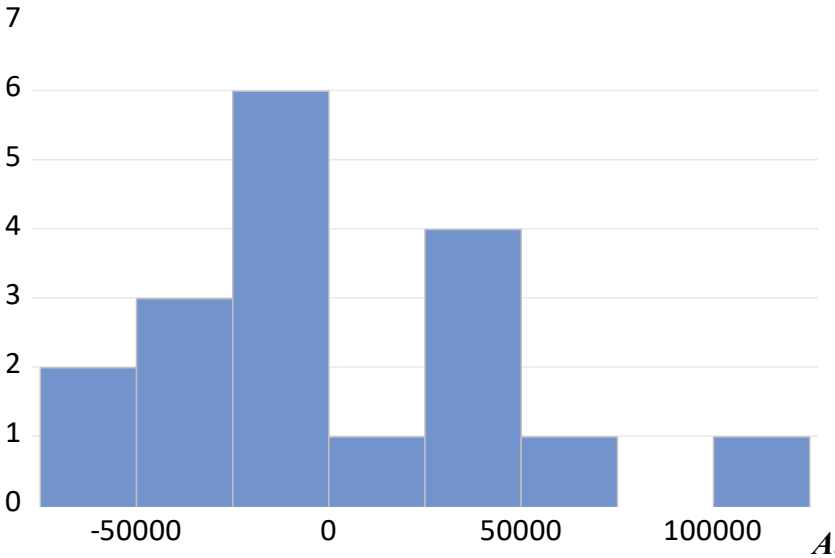
The regression equation is specified as:
$NPI = \beta_0 + \beta_1$ (Center Claim Paid) + β_2 (Square Claim paid) + β_3 (Center Claim Repudiated) + β_4 (Square Claim Repudiated) + ε
Where:
NPI = Dependent Variable (Net Premium Income)
β_0 = 282061.7 (Intercept)

β_1 = 0.675637 (Coefficient for centered claim paid)
β_2 = –8.48 × 10^{-7} (Coefficient for squared centered claim paid)
β_3 = –2.905166 (Coefficient for centered claim repudiated)
β_4 = 0.004942 (Coefficient for squared centered claim repudiated)
ε = Error term (residual)

Assumptions Diagnostics for Ordinary Least Squares (OLS)

To ensure the validity and reliability of Ordinary Least Squares (OLS), it depends on certain assumptions. It includes normality of residuals, linearity, independence of errors, absence of multicollinearity, and homoscedasticity (constant variance of residuals). Linearity describes the linear relationship between the independent and dependent variables, whereas independence describes that the residuals are not correlated with each other. Multicollinearity occurs when high correlations exist between two or more variables, which can increase the standard errors of the coefficients. Homoscedasticity signifies that the variance of errors is uniform across all levels of the independent variables. Finally, normality of residuals ensures validity of hypothesis testing and confidence intervals. Violation of any of these assumptions can lead to inefficient, biased, or invalid results (Wooldridge, 2016).

Figure 1.11: Normality of Residuals using Jarque-Bera Test



(Sources: Compiled by the Author from EViews 12)

Mean	-1.07e-10
Median	-16013.79
Maximum	114431.3
Minimum	-60029.59
Std. Dev.	44758.90
Skewness	0.890577
Kurtosis	3.403708
Jarque-Bera	2.501619
Probability	0.286273

The Jarque-Bera test was used to evaluate whether the residuals from the regression model confirm a normal distribution, as shown in **Fig. 1.11**. The analysis gives a Jarque-Bera statistic of 2.5016 with a p-value of 0.2863. The p-value is more than the standard level of significance 0.05. It means the null hypothesis of normally distributed residuals cannot be rejected. It indicates that the residuals are normal. The skewness value of 0.89 implies a modest rightward asymmetry, while the kurtosis value of 3.40 suggests a slightly leptokurtic distribution. However, both values are within acceptable ranges for the normality (Gujarati & Porter, 2009). The histogram of residuals visually supports the results of an approximately bell-shaped distribution.

Figure 1.12: Graphical Evaluation of Model Fit and Linearity for Net Premium Income

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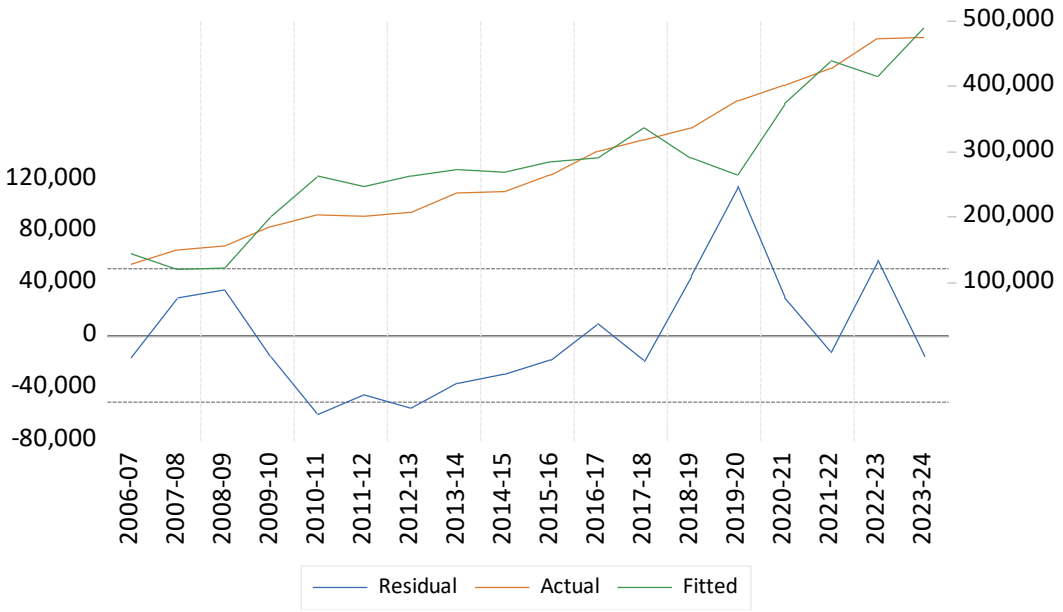

(Sources: EViews 12)

Figure 1.12 illustrates a comparison of the actual, fitted, and residual values of Net Premium Income (NPI) as given by the OLS regression model. The fitted values align with the actual trend across most of the observations. It indicates a good model fit. This visual alignment indicates a high R-squared value (0.839). It suggests that a significant percentage of the variation in the dependent variable is described by the independent variables. However, deviation between the actual and fitted lines appears in the mid and later data, where the model either slightly underestimates or overestimates the actual values. The residual line fluctuates around the zero line without a noticeable pattern. It supports the theory of random error terms. It indicates no strong evidence of autocorrelation or systematic bias in the model predictions (Gujarati & Porter, 2009). The Actual and Fitted lines reflect a strong alignment throughout the time series, particularly in the initial and intermediate periods. This visual relationship explains that the OLS model has successfully identified the linear trend in the data. Linearity indicates that the variations in the dependent variable are proportionately associated with deviations in the independent variables. The consistent difference between the Actual and Fitted lines across the observations supports this assumption (Wooldridge, 2016).

Figure 1.13: Linearity of Relationship using Ramsey RESET Test

	Value	df	Probability
t-statistic	1.654163	12	0.1240
F-statistic	2.736255	(1, 12)	0.1240
Likelihood ratio	3.697275	1	0.0545

(Source: Compiled by the Author from EViews 12)

Fig. 1.13 displays the Ramsey RESET test results, which support the assumption of linearity in the OLS regression model for Net Premium Income. The study investigates whether non-linear combinations of the fitted values explain the dependent variable, suggesting misspecification of the model. In this case, the P-values for the t-statistics (0.1240), F-statistic (0.1240), and likelihood ratio test (0.0545) are all more than the standard 5% level of

significance. Therefore, the null hypothesis fails to reject, indicating that the model is correctly specified (Gujarati & Porter, 2009; Wooldridge, 2016).

Figure 1.14: Heteroskedasticity in the OLS Model using Breusch-Pagan-Godfrey Test
Null Hypothesis: Homoskedasticity

F-statistics	0.337082	Prob.F(4,13)	0.8481
Obs*R-squared	1.691477	Prob. Chi-square(4)	0.7923
Scaled explained SS	1.060375	Prob. Chi-square	0.9005

(Source: Compiled by the Author from EViews 12)

Fig. 1.14 illustrates the findings of the Breusch-Pagan-Godfrey test, which evaluates the degree of heteroskedasticity in a regression model. The null hypothesis of this model assumes that the variance of the residuals is constant (homoskedasticity), a fundamental assumption of the classical linear regression model.

F-statistic p-value (0.8481), Obs*R-squared p-value (0.7923), Scaled explained SS p-value (0.9005), all of these p-values are significantly more than the 0.05 level. The researcher failed to reject the null hypothesis.
G-
The Breusch-Pagan-Godfrey model finding supports the assumption of homoskedasticity. Consequently, the error variance in the regression model seems to be constant. Satisfying one of the essential assumptions of the Classical Linear Regression Model (CLRM), which offers unbiased and efficient estimates (Gujarati & Porter, 2009).

Figure 1.15: Variance Inflation Factor (VIF) Analysis for Multicollinearity Diagnosis

Variables	Coefficient Variance	Uncentered VIF	Centered VIF
C	2.83E+08	1.945512	NA
Center of Policies Paid	0.015555	3.220821	3.220821
Center Square of Policies Paid	5.79E-14	2.789129	2.427602
Center of Repudiated/Rejected	61.37774	2.250103	2.250103
Center Square of Policies repudiated	2.86E-06	2.195875	1.637038

(Source: Compiled by the Author from EViews 12)

Fig. 1.15 illustrates the Variance Inflation Factor (VIF) results, which identify multicollinearity among the independent variables. Multicollinearity occurs due to a high correlation between two or more variables. It can bias the computed coefficients and diminish the statistical power of the regression analysis.

In this case, all centered VIF values are well below the conventional criteria of 10, and even below the more rigorous level of 5. The values of Center Claim Paid (3.22), Square Claim Paid (2.43), Center Claim Repudiated (2.25), and Square Claim Repudiated (1.64) indicate that multicollinearity is not a significant issue in this model.

A VIF value greater than 10 indicates harmful multicollinearity, but values under this level are typically considered acceptable (Gujarati & Porter, 2009). Therefore, based on these VIF

statistics, it has been concluded that the independent variables have no evidence of collinearity, and hence, the model's coefficient calculations are likely to be reliable.

Figure 1.16: Autocorrelation using the Breusch-Godfrey Serial Correlation LM Test
Null Hypothesis: No serial correlation at up to 2 lags

F-statistics	1.631499	Prob.F(2,11)	0.2396
Obs*R-squared	4.117926	Prob. Chi-square (2)	0.1276
Durbin-Watson Stat	1.82		

(Source: Compiled by the Author from EViews 12)

Fig. 1.16 diagnoses the presence of autocorrelation in the residuals of a regression model using the Breusch-Godfrey Serial correlation LM Test. The null hypothesis implies the absence of serial correlation up to the designated lag length- up to 2 lags, in this case. The Prob (F-statistic) is 0.2396 and the Prob (Chi-Square) is 0.1276, both are more as compare to the common level of significance 0.05. Therefore, the researcher failed to reject the null hypothesis, indicating the absence of autocorrelation in the model residuals. The Durbin-Watson statistic reported is 1.82, which is approximately near to the ideal value of 2. It suggests that the residuals are uncorrelated (Field, 2024) and concludes that autocorrelation is not a serious issue in this model. The lack of serial correlation indicates that the model's error terms are independent over time, and supports the validity of hypothesis testing results.

Malmquist Data Envelopment Analysis (DEA) Approach

The assessment of public sector financial organizations such as the Life Insurance Corporation of India (LIC), necessitates the measurement of operational efficiency to identify performance gaps, optimize resource utilization, and inform policy decisions. The study uses Data Envelopment Analysis (DEA), a non-parametric linear programming method established by Charnes, Cooper, & Rhodes (1978). As compared to traditional models, DEA facilitates the evaluation of relative efficiency over various periods, making it appropriate for assessing LIC's performance over 18 years. By formulating an empirical efficiency frontier each year, DEA determines the most efficient year(s) and quantifies the deviations of other years from this standard. It provides significant insights into LIC's evolving operational performance (Cooper, Seiford, & Tone, 2007; Saha & Satpathy, 2025). DEA provides cross-sectional benchmarking, while Malmquist DEA enables a longitudinal evaluation of productivity trends. It reveals whether advancements are due to internal efficiency or external progress in the operational environment.

Figure 1.17: Output Oriented Malmquist DEA (Distance Summary)

Year	Firm No.	CRS TE (t-1)	CRS TE (t)	CRS TE (t+1)	VRS TE
1	1	0.000	1.000	1.131	1.000
2	1	1.483	1.000	1.407	1.000
3	1	1.063	1.000	0.855	1.000
4	1	1.678	1.000	0.919	1.000
5	1	1.323	1.000	1.304	1.000
6	1	1.547	1.000	0.975	1.000
7	1	1.194	1.000	0.885	1.000
8	1	1.726	1.000	1.034	1.000

9	1	1.167	1.000	0.941	1.000
10	1	1.305	1.000	0.952	1.000
11	1	1.139	1.000	1.669	1.000
12	1	1.533	1.000	1.252	1.000
13	1	1.064	1.000	1.478	1.000
14	1	1.137	1.000	0.960	1.000
15	1	6.181	1.000	0.944	1.000
16	1	1.179	1.000	1.343	1.000
17	1	2.852	1.000	1.310	1.000
18	1	1.403	1.000	0.000	1.000

(Sources: Compiled by the Author from DEAP 2.1)

Fig. 1.17 provides the result of Malmquist Productivity Index (MPI) analysis using DEA (Data Envelopment Analysis) through DEAP 2.1 software over 18 years. An output-oriented approach (i.e., assessing efficiency by determining the extent to which output could be proportionally increased without increasing input) has been used. Each year shows, crs te t-1 (Distance from the previous year's technology), crs te t (Distance from the current year's technology, consistently 1.000 in this output), crs te t+1 (Distance from next year's technology), vrs te (Technical efficiency under Variable Returns to Scale, VRS, which remains same 1.000, indicating fully efficient each year). The DMUs reveal technical efficiency (VRS TE = 1.000) annually, indicating that the firm is operating on the VRS efficiency frontier.

Figure 1.18: Malmquist Index Summary

Year	Firm No.	Efficiency Change (Effch)	Technical Change (Techch)	Pure Efficiency Change (Pech)	Scale Efficiency Change (Sech)	Total Factor Productivity Change (TFPch=Effch x Techch)
2	1	1.000	1.145	1.000	1.000	1.145
3	1	1.000	0.870	1.000	1.000	0.870
4	1	1.000	1.401	1.000	1.000	1.401
5	1	1.000	1.200	1.000	1.000	1.200
6	1	1.000	1.089	1.000	1.000	1.089
7	1	1.000	1.106	1.000	1.000	1.106
8	1	1.000	1.397	1.000	1.000	1.397
9	1	1.000	1.062	1.000	1.000	1.062
10	1	1.000	1.177	1.000	1.000	1.177
11	1	1.000	1.094	1.000	1.000	1.094
12	1	1.000	0.958	1.000	1.000	0.958
13	1	1.000	0.922	1.000	1.000	0.922
14	1	1.000	0.877	1.000	1.000	0.877
15	1	1.000	2.538	1.000	1.000	2.538
16	1	1.000	1.118	1.000	1.000	1.118
17	1	1.000	1.457	1.000	1.000	1.457
18	1	1.000	1.035	1.000	1.000	1.035

(Sources: Compiled by the Author from DEAP 2.1)

Figure 1.19: Malmquist Index Summary of Annual Means

Year	Efficiency Change (Effch)	Technical Change (Techch)	Pure Efficiency Change (Pech)	Scale Efficiency Change (Sech)	Total Factor Productivity Change (TFPch=Effch x Techch)
2	1.000	1.145	1.000	1.000	1.145
3	1.000	0.870	1.000	1.000	0.870
4	1.000	1.401	1.000	1.000	1.401
5	1.000	1.200	1.000	1.000	1.200
6	1.000	1.089	1.000	1.000	1.089
7	1.000	1.106	1.000	1.000	1.106
8	1.000	1.397	1.000	1.000	1.397
9	1.000	1.062	1.000	1.000	1.062
10	1.000	1.177	1.000	1.000	1.177
11	1.000	1.094	1.000	1.000	1.094
12	1.000	0.958	1.000	1.000	0.958
13	1.000	0.922	1.000	1.000	0.922
14	1.000	0.877	1.000	1.000	0.877
15	1.000	2.538	1.000	1.000	2.538
16	1.000	1.118	1.000	1.000	1.118
17	1.000	1.457	1.000	1.000	1.457
18	1.000	1.035	1.000	1.000	1.035
Mean	1.000	1.162	1.000	1.000	1.162

(Sources: Compiled by the Author from DEAP 2.1)

Figure 1.20: Malmquist Index Summary of Firm Means

Firm No.	Efficiency Change (Effch)	Technical Change (Techch)	Pure Efficiency Change (Pech)	Scale Efficiency Change (Sech)	Total Factor Productivity Change (TFPch=Effch x Techch)
1	1.000	1.162	1.000	1.000	1.162
Mean	1.000	1.162	1.000	1.000	1.162

(Sources: Compiled by the Author from DEAP 2.1)

The findings from the DEAP Version 2.1 software provide a comprehensive evaluation of the firm's productivity and efficiency over 18 years using output-oriented Malmquist DEA analysis. The unit showed consistent technical efficiency across all years, as shown by a Technical Efficiency (Te) and Efficiency Change (EFFch) score of 1.000 each year. This indicates the DMU consistently functions on the efficiency frontier without any internal inefficiencies. The Pure Efficiency Change (PEch) and Scale Efficiency Change (SEch) values consistently maintained a level of 1.000, validating both managerial and scale efficiency throughout the period. The Total Factor Productivity Change (TFPch) varies due to technical change (TECHch), with an overall geometric mean of 1.162. It indicates an average 16.2% productivity enhancement driven purely by technological progress.

The peak productivity increase was recorded in Year 15 (TFPch = 2.538), whereas a significant reduction occurred in Year 3 (TFPch = 0.870) due to the global financial crisis. It significantly impacts the financial institutions globally, including India's insurance sector (IRDAI, 2009; RBI, 2009). And the changes occur in Year 14 (TFPch = 0.877) due to the outbreak of the COVID-19 pandemic, which disrupted economic activities drastically. The activities of LIC, particularly those requiring physical customer interaction (agent-based sales, claim settlement, paperwork), were notably impacted (IRDAI, 2020). The distance function (t-1) in DEA quantifies the deviations of a Decision-Making Unit (DMU) from the efficiency frontier. A value more than 1 indicates inefficiency; the DMU is generating less output than it could with the same input (or using more input than required). The t-1 score of Year 15 (2020-21) is 6.181, which is due to the second wave of COVID-19. This increased death claims, interruptions from lockdown, and temporary premium vacations, probably affecting LIC's input-output efficiency (IRDAI, 2021). In the subsequent year, 2021-22, LIC experienced irregular claim patterns and premium interruptions as LIC dealt with the immediate post-pandemic impacts, potentially shifting its DEA frontier (RBI, 2022). And the Year 17 (2022-23) t-1 value is 2.852, which is due to the effects of LIC's IPO, system enhancements, and increasing digital investments, which have increased inputs without immediate output advances, reflecting transitional inefficiencies (LIC, 2023).

Summary Of The Hypotheses

Hypotheses	Results
$H_0$1: There is no significant change in the claim settlement ratio of LIC of India during the research period.	Based on both Time Series Regression and Mann-Kendall Trend Test, the researcher **rejects the null hypothesis**. There is an increasing change in the claim settlement ratio by LIC of India during the research period.
$H_0$2: There is no significant change in the value of claims settled by LIC of India during the research period.	Based on both Time Series Regression and Mann-Kendall Trend Test, the researcher **rejects the null hypothesis**. There is an increasing change in the value of claims resolved by LIC of India during the research period.
$H_0$3: There is no significant association between the independent variables (Center Claim Paid, Square Claim Paid, Center Claim Repudiated, Square Claim Repudiated) and Net Premium Income.	Since the Prob (F-statistic) (0.000044) is less than 0.05 or o.01, the researcher **rejects the overall null hypothesis**. This indicates that atleast one of the independent variables has a significant impact on Net Premium Income.
$H_0$3a: The coefficient for Center Claim Paid is zero (no linear relationship with Net Premium Income).	Since the probability (0.0001) is lower than 0.05, the researcher **rejects the null hypothesis**. Center Claim Paid has a positive impact on Net Premium Income.
$H_0$3b: The coefficient for Square Claim Paid is zero (no quadratic relationship with Net Premium Income).	Since the probability (0.0037) is lower than 0.05, the researcher **rejects the null hypothesis**. There exists a statistically significant negative quadratic relationship between Square Claim Paid and Net Premium Income.

$H_0$3c: The coefficient for Center Claim Repudiated is zero.	Since the probability (0.7167) is more than 0.05, the researcher **fails to reject the null hypothesis**. There is no statistically significant relationship between Center Claim Repudiated and Net Premium Income.
$H_0$3d: The coefficient for Square Claim Repudiated is zero.	Since the probability (0.0119) lower than 0.05, the researcher **rejects the null hypothesis**. There is a statistically significant positive quadratic relationship between Square Claim Repudiated and Net Premium Income.
$H_0$4: There is no significant change in Total Factor Productivity Change (TFPch) for LIC of India over the observed period, meaning that any observed productivity changes are not statistically different from 1 (no change), and are not primarily driven by technological change.	The "Malmquist Index Summary of Firm Means" shows a mean Total Factor Productivity Change (TFPch) of **1.162**. As the value is more than 1, it indicates an average increase in total factor productivity over the observed period. Again, the analysis states that "productivity changes are entirely driven by technological changes (Techch)", as the mean Technological Change (Techch) is also **1.162** and the mean Efficiency Change (Effch) is **1.000**. Therefore, the researcher **rejects the null hypothesis.**
$H_0$4a: The firm consistently operates at the efficiency frontier (Effch = 1.000) under variable returns to scale (VRS) assumptions, and there are no significant changes in efficiency over time.	The output states that "The values for VRS TE (Variable Returns to Scale Technical Efficiency) are consistently 1.000". It indicates the firm is "fully efficient in transforming inputs into outputs within each year". The "Malmquist Index Summary" consistently shows "effch" at **1.000** for all years. The mean Effch over the entire period is also **1.000**. Therefore, the researcher **accepts the null hypothesis (H0)**. LIC of India consistently operated at the efficiency frontier under VRS assumptions, showing no significant changes in efficiency over the period.

$H_0$4b: Technological change (Techch) does not significantly contribute to Total Factor Productivity Change (TFPch) over the period.	The mean of Technological Changes (Techch) is **1.162**, which is more than 1, indicating technological progress. The results state that "productivity changes are entirely driven by technological changes (Techch)". For example, in Year 15, a Techch of 2.538 is noted as a "major leap in technology adoption or innovation". Therefore, the researcher **rejects the null hypothesis.** Technological change is indeed the primary and significant driver of Total Factor Productivity change for LIC of India over the observed period.

Findings Of The Study

LIC has continuously achieved a high Claim Settlement Ratio (CSR), attaining 98.74% in 2021-22, particularly during the COVID-19 pandemic. The Mann-Kendall trend test and Time Series Regression reveal a positive and statistically significant trend in the CSR. The continuously high CSR increases policyholder confidence and develops robust competitive advantage of the firm. This maintains LIC's image as a reliable insurer, boosting customer retention and acquisition of new policies, particularly in a competitive market with many private competitors. It also supports its operational efficiency in claim processing. LIC's performance sets as an example for the industry and builds overall confidence in the insurance sector. Regulators like IRDAI can leverage this data to promote best practices and create industry wide benchmarks for claim settlement, ensuring that policyholders get their entitled benefits promptly. This also helps in diminishing the trust gap that sometimes arises among prospective policyholders about insurance disbursements.

Minimization of repudiation and unclaimed claims is important. High repudiation can severely damage trust, resulting to adverse publicity and decline in the market share. LIC must consistently evaluate its underwriting procedures, policy conditions and communication tactics to ensure transparency and proper disclosure. For unclaimed claim, effective policyholder tracing methods and proactive communication are crucial to guarantee that legitimate beneficiaries get their entitlements, hence improving company's ethical reputations. To reduce repudiation rates throughout the industry, it is essential to standardize paperwork requirements, enhance consumer education about policy terms and conditions, and use technology for more initial assessments. For unclaimed funds, collaborative initiatives among insurers and regulators to create consolidated databases or streamlined recovery methods can benefit the entire market, and boost financial inclusion and strengthen consumer safety.

The paper highlights 2023-24 as the most efficient year for claim pending ratio (0.03%), with 2008-09 being the least efficient (2.21%). This indicates improvements in process efficiency over time. A low claim pending ratio indicates efficient operational process, quicker turnaround times, and perhaps effective use of technology and personnel in claim processing. This immediately enhances customer satisfaction and mitigates operational bottlenecks and expenses related to delayed claims. LIC should recognize the methods used during productive

years (like 2023-24) and formalize them. The prompt payment of claims is a crucial performance metric for the whole business. Regulators may facilitate digital claim filing and processing, implement Service Level Agreements (SLAs) for various claim types, and promote data driven insights to identify and mitigate the causes of claim delays across all insurers. This fosters a more efficient and customer-oriented insurance environment.

LIC need to persist in its investments in AI, automation and data analytics to enhance claim processing efficiency, minimize human errors, and accelerate payment durations. Digital systems for claim notification and document submission may greatly enhance customer experiences. The success notified at LIC, inherently associated with digital adoption, should motivate other insurers to accelerate their efforts to digitally transform. This includes development of the user-friendly online portals, the integration of AI for fraud detection, the automation of challenging operations, and the use of data analytics for predictive insights into claim patterns.

The paper reveals that claim settlement is not only an operational task but a vital determinant of an insurer's reputation and trust. Policy and practice must continually emphasize efficient and prompt settlements to foster and sustain public trust in insurance products. IRDAI can use the findings from this research to enhance legislation concerning claim processing, establish more rigorous standards for claim settlement ratios and turnaround times, and ensure transparency in repudiation procedures.

LIC and other insurers, supported by regulatory bodies, must take efforts to educate policyholders on the complete claim procedure, necessary paperwork, and the significance of full disclosure during policy acquisition to reduce repudiation. The results underscore the need of using digital technologies and automation in claim administration.

The study emphasizes the fundamental subject of claim settlement that naturally involves ethical problems. Policies must prioritize equitable and impartial claim evaluation, ensuring that technologies such as AI do not add or increase existing biases, particularly in automated systems. This research establishes a strong statistical basis that supports the claim settlement as a “cornerstone of insurer credibility”. The results provide a valuable framework for LIC to maintain its strong performance. The results and findings are significant for the wider Indian insurance industry and its regulators to formulate rules and best practices that improve efficiency, transparency and most importantly, policyholder trust.

Conclusion

The evaluation of Life Insurance Corporation of India's (LIC) claims settlement performance from 2006-07 to 2023-24 confirms its position as a reliable & successful insurer, particularly in the evolving Indian market. There is a consistently high claim settlement ratio, along with statistically significant positive trends in the claim settlement ratio and the total value of claims settled. It explains LIC’s ongoing enhancement in operational efficiency and responsiveness to policyholders. Notably, LIC effectively managed a significant rise in death claims during the COVID-19 pandemic, sustaining elevated settlement rates and preventing unusual rises in pending claims, highlighting its strong infrastructure and flexibility.

The decrease in rejected and unclaimed claims, along with a notable reduction in pending claims over time, further highlight LIC’s commitment to transparency, ethical underwriting,

and customer happiness. These improvements are mostly due to strategic digital transformations, optimized procedures, the large support of its vast agent network in bridging digital literacy deficiencies in rural areas, and the proactive influence of IRDAI's regulatory changes.

The regression analysis indicates there is a significant impact of the number of policies paid and the number of policies repudiated on the net premium income of LIC of India, which reflects its operational dynamics. The Malmquist Data Envelopment Analysis (DEA) verifies that LIC constantly maintained its internal efficiency, with productivity improvements due to technical advancement. However, exogenous shocks like the global financial crisis, COVID-19, and structural transformation (IPO, digitalisation) create temporary productivity fluctuations. This highlights that while LIC's internal efficiency remained consistent, external forces substantially influenced its productivity patterns within India's insurance industry.

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