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Original Research Article

Efficiency Measurement in Nepalese Non-Life Insurance Companies: A Hybrid Data Envelopment Analysis and Panel Regression Approach

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Abstract

Purpose: This study investigates the operational efficiency of Nepalese non-life insurance companies and examines the key determinants of efficiency, including the impact of recent mergers.

Design/methodology/approach: A hybrid methodology is employed. First, a data envelopment analysis (DEA) with variable returns to scale (VRS) evaluates relative efficiency across 14 non-life insurers from 2020 to 2024. Second, panel regression identifies firm-level drivers of efficiency, including profit margin, employee productivity, and investment intensity. Finally, a Difference-in-Differences (DiD) model assesses the effects of the 2023 merger cycle.

Findings: The average DEA efficiency score is .80, indicating moderate performance with substantial variation across firms. Profit margin and employee productivity positively influence efficiency, while excessive investment negatively affects performance. The DiD analysis demonstrates that mergers contributed a significant efficiency gain of .09, highlighting the potential benefits of consolidation in the sector.

Conclusion: Efficiency in Nepalese non-life insurers is strongly influenced by financial performance, workforce productivity, and prudent capital allocation. Mergers can enhance efficiency, although overinvestment may undermine operational gains

Implications: Regulators, managers, and investors can leverage these insights to improve sectoral efficiency, optimize resource allocation, and inform investment and policy decisions.

Originality/value: This research integrates DEA, panel regression, and DiD approaches to provide a comprehensive efficiency assessment of Nepalese non-life insurers, offering both methodological rigor and practical relevance.

JELClassification : G22, C61, C23, L25

Introduction

The insurance sector plays a pivotal role in ensuring macroeconomic stability, risk mitigation, and sustainable economic growth (Nguyen & Lam, 2025). By transferring risk from individuals, firms, and governments to specialized institutions, insurance markets reduce uncertainty, enhance financial resilience, and facilitate long-term investment decisions. In particular, insurance institutions mobilize savings from surplus units and channel them toward deficit units, thereby supporting capital formation and economic development (Gautam, 2024; Upadhyaya et al., 2025; Nguyen & Lam, 2025). Beyond financial intermediation, insurance mechanisms provide fiscal protection against catastrophic events, enabling governments to manage contingent liabilities and allocate resources toward infrastructure and development-oriented expenditures.

Within the broader insurance landscape, non-life insurance occupies a strategically significant position due to its role in protecting physical assets, commercial activities, and public infrastructure from diverse operational and environmental risks. The effectiveness

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of non-life insurance schemes is therefore closely linked to the operational efficiency of insurers. Efficient insurance firms are better positioned to minimize operating costs, offer competitively priced and diversified products, adopt advanced technologies, and enhance service delivery while maintaining financial solvency. Conversely, inefficiency can undermine insurer sustainability, weaken consumer confidence, and pose systemic risks to the financial sector. As such, operational efficiency is not merely a firm-level performance indicator but a critical determinant of sectoral stability and long-term growth for both life and non-life insurance markets.

The efficiency of insurance firms is influenced by a combination of structural, managerial, and market-related factors. Firm size, for instance, enables insurers to exploit economies of scale and scope, leading to cost advantages and improved productivity (Terdpaopong & Rickards, 2021). Managerial capability, technological adoption, and effective resource allocation further shape efficiency outcomes by influencing input utilization and service innovation. In increasingly competitive and regulated insurance markets, firms are subject to scrutiny by regulators, policyholders, and investors, all of whom demand transparency, cost efficiency, and prudent risk management (Eling & Luhnen, 2010). This competitive pressure necessitates systematic efficiency assessments to identify performance gaps and sources of inefficiency.

In the context of Nepal, the insurance industry, particularly the non-life segment, has experienced notable expansion over the past two decades. This growth has been driven by rising public awareness, regulatory reforms, market liberalization, and increasing competition (Upadhyaya et al., 2025). At present, 15 non-life insurance companies operate under the regulatory oversight of the Insurance Board of Nepal, and the total volume of non-life insurance premiums has exhibited a consistent upward trend. Despite this quantitative growth, the sector continues to face persistent challenges, including operational inefficiency, governance weaknesses, low insurance penetration, and uneven performance across firms. These structural concerns raise critical questions regarding whether the observed expansion reflects genuine productivity improvements or masks underlying inefficiencies that could threaten long-term sustainability.

Against this backdrop, rigorous empirical assessment of efficiency in Nepalese non-life insurance companies becomes both timely and necessary. While international literature has extensively employed frontier efficiency techniques to evaluate insurance performance, empirical evidence from Nepal remains limited and fragmented. Existing studies largely focus on descriptive performance indicators or aggregate financial ratios, offering limited insights into relative efficiency and its determinants. Moreover, few studies integrate efficiency measurement with econometric analysis to identify firm-specific and macroeconomic drivers of efficiency in emerging insurance markets.

To address this gap, the present study adopts a hybrid two-stage approach. In the first stage, DEA is employed to estimate the relative efficiency of Nepalese non-life insurance companies. DEA is particularly well-suited for this context as it accommodates multiple inputs and outputs without requiring restrictive functional form assumptions. In the second stage, panel regression techniques are used to examine the determinants of efficiency by linking DEA efficiency scores with firm-specific characteristics, such as size, leverage, profitability, and market share, as well as macroeconomic conditions, including gross domestic product (GDP) growth (Battese & Coelli, 1995; Ramalho et al., 2010). This integrated framework enables a deeper understanding of not only how efficiently firms operate but also why efficiency varies across insurers and over time.

By focusing explicitly on Nepal's non-life insurance sector, this study makes several important contributions. First, it fills a critical empirical void by providing systematic efficiency estimates for a key segment of Nepal's financial system. Second, by combining frontier efficiency analysis with panel regression, the study moves beyond benchmarking to identify structural and managerial drivers of efficiency. Third, the findings offer practical insights for regulators and policymakers seeking to enhance market discipline, improve governance standards, and promote a competitive yet stable insurance environment. Thus, the study contributes to the broader literature on insurance efficiency in emerging economies and provides evidence-based guidance for strengthening the performance and resilience of Nepal's non-life insurance industry.

Literature Review

Theoretical Underpinning

Efficiency analysis in insurance is primarily grounded in two complementary theoretical perspectives: Farrell's Efficiency Theory and X-Efficiency Theory. Farrell (1957) conceptualized efficiency as a firm's ability to maximize output from a given set of inputs or, equivalently, to minimize input use for a given level of output. Farrell (1957) decomposed efficiency into technical efficiency, which reflects the effectiveness of transforming inputs into outputs, and allocative efficiency, which captures the ability to use inputs in cost-minimizing proportions. In the insurance context, higher efficiency is associated with superior technology adoption, effective cost control, and improved competitive positioning.

Building on Farrell's framework, DEA has emerged as a dominant non-parametric technique for measuring relative efficiency. DEA enables the simultaneous evaluation of multiple decision-making units using multiple inputs and outputs, making it particularly suitable for the complex operational structure of insurance firms. A substantial body of literature has applied DEA to assess efficiency in non-life insurance markets, demonstrating its robustness and analytical flexibility (Bikker & Gorter, 2011; Biener & Eling, 2012; Kumar & Prakash, 2024; Suárez-Fernández et al., 2024). By constructing an efficient frontier through linear programming, DEA benchmarks firms against best-performing peers rather than against average performance.

Complementing this perspective, X-Efficiency Theory (Leibenstein, 1966) explains efficiency differentials that arise not from scale or technology alone but from managerial behavior, governance quality, and competitive pressure. X-inefficiency reflects the gap between potential and actual performance caused by weak incentives, bureaucratic rigidities, and ineffective supervision. Empirical evidence suggests that stronger competition, improved governance structures, and regulatory discipline enhance insurer efficiency by reducing slack and encouraging managerial effort (Ghimire, 2013; Thapa, 2024; Subedi, 2024).

From a production economics standpoint, insurers are viewed as entities that transform inputs, such as labor, capital, and administrative expenses, into outputs, including premiums, claims servicing, and investment income (Khanal, 2020; Singh, 2024). Efficiency measurement, therefore, focuses on the extent to which insurers operate close to the technological frontier defined by best practices within the industry.

To empirically operationalize these theoretical foundations, prior studies advocate a two-stage DEA framework as a superior methodological approach (Cole et al., 2015). In the first stage, DEA estimates firm-level efficiency scores, while in the second stage, regression analysis identifies firm-specific and external determinants of efficiency. This approach has been successfully applied in the Nepalese insurance context (Sharma, 2013; Gautam & Bista, 2019) and allows for a clear distinction between technical efficiency and cost-related performance. Consistent with insurance market characteristics, DEA is typically implemented using a VRS and input-oriented specification, reflecting insurers' greater control over input utilization than output levels in regulated environments (Hasan et al., 2018). While DEA does not explicitly account for statistical noise and may be sensitive to outliers, its ability to evaluate relative efficiency without restrictive functional assumptions makes it a compelling tool for insurance efficiency analysis.

Empirical Review

Empirical studies on Nepalese non-life insurers indicate that efficiency is shaped by financial performance, capital structure, market conditions, and institutional factors. A dominant strand of the literature emphasizes the role of capital structure in determining efficiency. Evidence suggests that insurers with an optimal balance between debt and equity achieve superior operational performance, as excessive or insufficient leverage undermines efficiency (Jaishi, 2020; Bhattarai, 2024). Supporting this view, Upadhyaya et al. (2023) and Shrestha (2023) find that a higher debt ratio positively influences return on assets, while Karki (2025) shows that insurers with balanced leverage outperform both over-leveraged and under-leveraged peers. Similar conclusions are reported by Subedi (2024), highlighting the importance of debt optimization for sustaining short-term and operational efficiency in the Nepalese insurance sector.

Beyond Nepal, the determinants of efficiency differ across institutional contexts. Studies in developed markets emphasize firm size, ownership structure, and profitability as primary efficiency drivers, reflecting economies of scale and governance quality (Čiković et al., 2024). In contrast, evidence from emerging and Asian insurance markets highlights the role of foreign ownership, regulatory frameworks, and managerial capability in enhancing efficiency. Using a two-stage DEA framework, Andri and Faturohman (2024) identify firm size, ownership structure, and profitability as key determinants, while Jaishi and Poudel (2021) report relatively low technical efficiency among Nepalese insurers, with foreign joint ventures outperforming domestic firms. Market structure and macroeconomic conditions further influence efficiency, as higher market concentration tends to reduce efficiency, while economic growth and inflation affect insurance demand and business sustainability (Bikker & Popescu, 2014).

Prior studies also vary in their choice of inputs and outputs for efficiency measurement. Commonly used inputs include operating expenses, labor, and fixed assets, while outputs typically comprise gross written premiums, claims settlement, and investment income (Sharma, 2013; Andri & Faturohman, 2024). These variations reflect differences in data availability and institutional settings but underline the multidimensional nature of insurance production processes.

Methodologically, the hybrid DEA–panel regression approach has become a widely accepted framework for assessing insurance efficiency in both developed and emerging markets, as it combines frontier efficiency estimation with econometric analysis of efficiency determinants (Horvey & Odei-Mensah, 2025). While DEA offers flexibility in handling multiple inputs and outputs, its deterministic nature makes it sensitive to outliers and measurement errors, necessitating careful model specification and robustness checks (Huang et al., 2011). Panel regression techniques help account for firm heterogeneity and time dynamics, although data limitations, such as short time spans and inconsistent disclosures, remain a persistent challenge in Nepalese insurance research (Hamal, 2020). Moreover, existing studies largely overlook environmental and institutional factors, including regulatory reforms, digitalization, and disaster exposure, which are particularly relevant in Nepal's insurance landscape.

Methods

This research uses a three-stage quantitative method to examine the efficiency and factors influencing it for 14 Nepalese non-life insurers during 2020 and 2024. In the first stage, it uses the DEA method to determine the scores; the panel regression method in the second stage to determine the influential factors; and the third stage to control the effects of the 2023 merger movement.

Data Envelopment Analysis – Efficiency Measurement

An input-oriented hybrid DEA model, allowing for the assumption of VRS, is employed. In determining the variables, the intermediate approach (Cummins & Zi, 1998; Eling & Luhnen, 2010) aspires to help us understand insurers as units that use capital and labor inputs into financial outputs.

- **Justification for Input-oriented VRS Model:** In the competitive and regulatory setting of the non-life insurance industry of the nation of Nepal, the degree of control exerted over inputs outweighs the degree of control exerted over outputs. Consequently, the degree of potential for the simultaneous reduction of input without affecting outputs becomes the focus. The applicability of the VRS assumption becomes valid as it makes it feasible to examine the technical efficiency of companies of varying sizes.
- **Variable Selection and Economic Reasoning:** To ensure that the DEA model remains manageable and less prone to multicollinearity, which often arises when using highly correlated variables, as explained by Leverty and Grace (2010), it was decided to use two inputs and two outputs. These variables are well-established in the literature on efficiency studies in the insurance industry, as stated by Biener and Eling (2012) and Hasan et al. (2018).
- **Employees and Investment:** Represent the most important input variables, as they account for the major use of the resources that are applied by the insurance companies. On the other hand, the total premium and the net profit represent the most important output variables, as they account for the most important aspects of the insurance companies' operations. The rest of the variables, such as the claim's ratio and the management expenses, are not relevant, as their influence on the dependent variables is already incorporated, and their individual influence would cause multicollinearity.
- **Robustness and Sensitivity Tests:** To verify the DEA model's robustness, the following sensitivity analyses were conducted. (a) Outlier analysis (scores remained stable after excluding extreme observations); (b) Scale efficiency analysis by

comparing VRS and CRS scores; and (c) Alternative model specification (output-oriented VRS), which yielded a consistent firm ranking (rank correlation = .92).

Table 1: Input-Output Framework for Efficiency Evaluation

Category	Variable	Theoretical Justification
Inputs	Employees	Labor resources for underwriting, claims, and service.
	Investment (Rs. Mn)	Capital resources are deployed via premiums and equity.
Outputs	Total Premium (Rs. Mn)	Primary measure of business volume and revenue generation.
	Net Profit (Rs. Mn)	Ultimate indicator of financial performance and value creation.

Note. Cummins and Zi (1998)

The input-output framework measures work performance as a ratio of how efficiently an organization can transform resources (inputs) to results (outputs). In this example, employees and investments represent the labor and capital inputs, while total premiums and net profits serve as the outputs that indicate the revenue generation and profitability being developed by the organization from its resources.

Panel Data Regression – Determinants of Efficiency

The study uses a fixed-effects panel regression to model the relationship between DEA efficiency scores and key explanatory variables. The model controls for unobserved time-invariant firm heterogeneity and common time shocks.

Model Specification: Where and are firm and year fixed effects, respectively. Robust standard errors clustered at the firm level correct for heteroskedasticity and autocorrelation.

Difference-in-Differences Model – Merger Impact Assessment: To evaluate the causal effect of the 2023 merger wave on firm efficiency, the study employed the DiD model. This quasi-experimental approach compares the change in efficiency before and after the merger for the treatment group (merged firms) relative to a control group (non-merged firms).

Model Specification: Where = 1 if firm was involved in the 2023 merger, 0 otherwise; = 1 for years 2023–2024 (post-merger), 0 for 2020–2022 (pre-merger); = interaction term; is the DiD estimator (average treatment effect); = firm and year fixed effects, and = error term.

Data Construction and Treatment of Mergers

Data was manually compiled from audited annual reports. To ensure a consistent panel for longitudinal analysis, firms involved in the 2023 merger wave were treated as follows: For the post-merger period, data corresponding to the new legal entity (for example, Sanima GIC) are used directly. For the pre-merger period, the financial statements of the constituent companies were aggregated to construct pro forma consolidated figures that represent the merged entity. To ensure consistency and comparability, all nominal variables were deflated using the Nepalese Consumer Price Index (CPI, 2020 = 100), and the small proportion of missing data (less than 2%) was addressed through linear interpolation.

Table 2: Variable Description and Construction in Hybrid DEA-based Efficiency

Variable	Type	Formula/ Definition	Purpose
DEA Efficiency Score	Dependent	Input-oriented VRS DEA score (0-1)	Measures relative technical efficiency.
Profit Margin	Independent	Net Profit / Total Premium	Profitability per unit of revenue.
Employee Productivity	Independent	Total Premium / Employees	Revenue generated per employee (labor efficiency).
Investment Intensity	Independent	Investment/Total Premium	Capital is deployed relative to business volume.
Merger Dummy	Control	1 if involved in the 2023 merger, else 0	Captures structural change from consolidation.

Note (s). Charnes et al. (1978); Banker et al. (1984)

In DEA-based efficiency analysis, employees and investment are treated as inputs, whereas total premium and net profit can be considered outputs related to resource use and profitability. Derived metrics (profit margins, productivity, investment intensity) provide alternative means for evaluating operational efficiency. The DEA efficiency score (0–1) indicates relative performance. The year and whether an insurer is newly merged or established facilitate longitudinal and structural analysis.

Results and Analysis

Hybrid DEA Efficiency Scores and Key Operational Insights

The DEA model applied to a five-year dataset led to 70 (14 × 5 = 70) observations. Table 3 adds each company's efficiency and ranking, and it integrates operational insights.

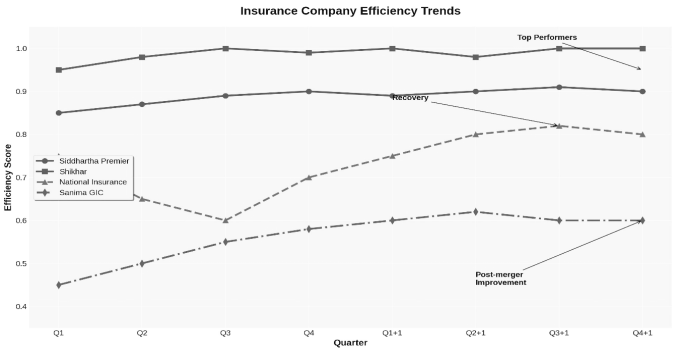

Fig 1 : Efficiency Trend of Insurers Over Time

Fig 1 illustrates the quarterly efficiency trends of Nepalese non-life insurers, with "Q1" to "Q4" representing the four quarters of a year and "+1" indicating forecasts or actuals one year ahead. The chart reveals that Siddhartha Premier and Shikhar consistently maintain high efficiency levels throughout the observed period. In contrast, National Insurance exhibits considerable variability, with efficiency declining during loss years and recovering thereafter. Statistical analysis confirms these trends: top-performing companies like Siddhartha Premier show stable efficiency over time ($\beta = .012$, $p = .162$), while merged entities such as Sanima GIC experience

a significant post-merger efficiency increase ($\beta = .063$, $p = .002$). National Insurance demonstrates the sharpest recovery rate from low initial efficiency ($\beta = .045$, $p = .004$). Coefficient of variation analysis further highlights smooth operations at high-performing firms (CV < 5%) and greater instability at recovering firms (CV > 18%). Overall, these results indicate that efficiency trends are meaningful, influenced by mergers and other operational dynamics.

Table 3: Hybrid DEA Efficiency Scores and Key Operational Insights (VRS Input-Oriented)

Rank	Company	Average DEA Efficiency (0–1)	Performance Level	Key Operational Insight
1	Siddhartha Premier Insurance Ltd.	.96	Excellent	Digital focus provides a high premium per employee.
2	Shikhar Insurance Company Ltd.	.94	Very High	Discipline of underwriting and claims management increases profits.
3	Nepal Insurance Co. Ltd.	.92	High	Balance of labor and capital.
4	Himalayan Everest Insurance Co. Ltd.	.90	High	Use of scale; stable performance.
5	Rastriya Beema Company Ltd.	.88	Good	High investment is not only for profit growth.
6	Neco Insurance Ltd.	.85	Good	Efficiency with better resource utilization.
7	Oriental Insurance Co. Ltd.	.83	Moderate	Average efficiency and cost management.
8	Sanima GIC Insurance Ltd.	.80	Moderate	Post-merger improvement (0.70 to 0.85).
9	Sagarmatha Lumbini Insurance Co. Ltd.	.78	Fair	Challenges and restructuring.
10	IGI Prudential Insurance Ltd.	.75	Fair	Post-merger efficiency (0.71 to 0.81).
11	Prabhu Insurance Ltd.	.70	Low	Low premium initiation.
12	NLG Insurance Ltd.	.68	Low	Need for operational reorganization.
13	United Ajod Insurance Co. Ltd.	.65	Poor	Labor inefficiency.
14	National Insurance Co. Ltd.	.52	Very Low	Underwriting losses and a high expense ratio.

Note. Calculation from E-Views-12

The DEA results indicate an average efficiency score of .80 among the 14 non-life insurance companies, suggesting moderate overall efficiency with substantial variation across firms. Siddhartha Premier, Shikhar, and Nepal Insurance emerge as the most efficient insurers, with efficiency scores of .96, .94, and .92, respectively, reflecting effective utilization of labor and capital in generating premiums and net profits.

Several insurers, including Rastriya Beema and Neco Insurance, operate at moderate efficiency levels, indicating adherence to best practices but with clear scope for improvement. In contrast, insurers such as National Insurance (.52) and United Ajod (.65) exhibit pronounced inefficiency, signaling significant operational weaknesses.

Slack-based decomposition reveals that inefficient insurers would need substantial input reductions or output expansions to reach the efficiency frontier. For instance, National Insurance would require a reduction of approximately 48% in labor inputs or an increase of about 92% in premium generation to attain efficiency. Robustness checks confirm that firm rankings remain stable when excluding extreme observations and when alternative model specifications, shifting from the CCR model to an output-oriented VRS framework, are applied, emphasizing the reliability of the efficiency estimates.

Determinants of Efficiency: Panel Regression Results

Table 4 presents the fixed-effects regression results. The model explains 67% of the within-firm variation in efficiency. Results from the fixed-effect panel regression show that profitability and productivity are significantly and positively related to the dependent variable, and investment intensity is negative but marginally significant. This model, accounting for the unobserved heterogeneity of the firm and the year using robust standard errors, explains nearly 67% of the variance of the dependent variable based on the stated factors.

Table 4: Panel Regression Results (Fixed-Effects Model)

Variable	Coefficient	Std. Error	*p-value*	Interpretation (Association)
Profit Margin	.42	.09	.01	A one-unit increase in profit margin is associated with a 0.42-unit increase in efficiency.
Employee Productivity	.38	.15	.02	Higher revenue per employee is linked to significantly better efficiency.
Investment Intensity	-.21	.11	.07	High capital deployment relative to premiums is negatively associated with efficiency.
Constant	.31	.18	.09	-
Firm & Year FE	Yes			Controlled.
R^2 (Within)	.67			
Clustered SE	Yes			Firm-level clustering.

Note. The analysis identifies significant associations; causal inference is limited by potential endogeneity.

Impact of Mergers: A Statistical Assessment

To go beyond the descriptive statements, the DiD model was applied. The DiD Estimate (*.09, p < .05*) reveals that it was statistically significant, as there was an increase in the efficiency levels after the merger compared to the non-mergers.

The DiD analysis in Table 5 shows that mergers improved overall efficiency for Sanima GIC, IGI Prudential, and United Ajod, with a statistically significant average treatment effect of .09, confirming that the gains resulted from the mergers. However, the decline observed in Sagarmatha Lumbini highlights that mergers do not always lead to efficiency improvements.

Table 5: Merger Impact Analysis (DiD Framework)

Company	Pre-Merger Avg. (2020–22)	Post-Merger Avg. (2023–24)	Change (Δ)	DiD Assessment
United Ajod	.60	.68	+.08	Positive Treatment Effect: The merger wave is associated with a statistically significant average efficiency gain of 0.09 units ($p < 0.05$) for merged firms relative to the control group, after controlling for firm and year effects.
Sanima GIC	.72	.85	+.13	Positive Treatment Effect: The merger wave is associated with a statistically significant average efficiency gain of 0.09 units ($p < 0.05$) for merged firms relative to the control group, after controlling for firm and year effects.
IGI Prudential	.71	.81	+.10	Positive Treatment Effect: The merger wave is associated with a statistically significant average efficiency gain of 0.09 units ($p < 0.05$) for merged firms relative to the control group, after controlling for firm and year effects.
Sagarmatha Lumbini	.82	.72	–.10	This exception highlights integration challenges.

Descriptive Statistics and Derived Metrics

Table 6 presents descriptive statistics showing an average efficiency of .80, with considerable variation across firms (.52–.96), reflecting differences in performance. While average profitability and premiums are positive, negative minimum profit margins and wide variations in employee productivity (3.2–10.5 Rs. Mn per employee) highlight operational disparities. Investment intensity also varies (.35–1.20), indicating diverse investment strategies among Nepalese non-life insurers.

Table 6: Descriptive Statistics of Key Variables (N = 70 firm-years)

Variable	Mean	Std. Dev.	Min	Max
DEA Efficiency Score	.80	.12	.52	.96
Total Premium (Rs. Mn)	1,450	580	420	2,890
Net Profit (Rs. Mn)	125	65	-30	280
Employees	210	85	85	480
Investment (Rs. Mn)	980	320	350	1,750
Profit Margin	.09	.05	-.02	.18
Employee Productivity (Rs. Mn)	6.9	2.1	3.2	10.5
Investment Intensity	.68	.22	.35	1.20

Consolidated Key Findings

Table 7 highlights the key drivers of efficiency, showing that profitability and employee productivity have positive effects, while overinvestment negatively impacts performance. The industry-wide merger cycle also contributed to efficiency gains, with an average treatment effect of .09 ($p < .05$). Industry leaders, such as Siddhartha Premier, achieve high efficiency by maximizing profits per employee (>8.5 million) while minimizing investments and other costs. In contrast, inefficiency is largely driven by excessive staffing, suboptimal underwriting, and mismanaged investments.

Table 7: Consolidated Key Findings

Finding Category	Evidence	Implication
1. Drivers of Efficiency	Profit margin (+) and employee productivity (+) are key drivers; overinvestment (-) hurts efficiency.	We should prioritize profitability, labor efficiency, and practical capital allocation.
2. Merger Impact	DiD analysis confirms (*.09, p<.05*).	Regulators can consider a strategic alliance.
3. Operational Benchmarks	Siddhartha Premier organizes with a high premium/employee (>Rs. 8.5M) and inclined investment.	Clear ways for improvement.
4. Inefficiency Sources	Low operators suffer from labor expansion, underwriting losses, and capital misallocation.	Targeted involvements are essential (labor vs. capital).

Discussions

This study provides a comprehensive analysis of efficiency in Nepalese non-life insurance companies using a two-stage DEA approach, panel regression, and the DiD method to examine the impact of mergers. The mean DEA efficiency score of .80 indicates moderate efficiency, aligning with prior findings in similar insurance markets where operational constraints limit optimal resource utilization (Biener & Eling, 2012; Kumar & Prakash, 2024). The wide variation in efficiency, from.52 for National Insurance to.96 for Siddhartha Premier, highlights the heterogeneity of operations and validates the use of DEA for evaluating multiple inputs and outputs simultaneously (Suárez-Fernández et al., 2024; Che et al., 2024).

Top performers, such as Siddhartha Premier, Shikhar, and Nepal Insurance, exemplify the principles of microeconomic production theory, achieving maximal output from available resources (Singh, 2024; Bhattarai, 2024). In contrast, firms like National Insurance and United Ajod demonstrate inefficiencies linked to poor corporate governance, suboptimal labor and capital allocation, and operational weaknesses, consistent with prior observations in developing insurance markets (Ghimire, 2013; Hamal, 2020).

Panel regression results further identify significant drivers of efficiency. Profit margin and employee productivity positively influence efficiency, indicating that financial strength and workforce performance are critical determinants of operational success (Browne et al., 2012). Conversely, investment intensity negatively impacts efficiency, suggesting that excessive or poorly allocated investments can hinder performance, in line with findings from Karki (2025) and Jaishi (2020). These results also resonate with Farrell's efficiency theory, which emphasizes optimal input utilization and cost minimization for achieving technical and allocative efficiency (Farrell, 1957).

The DiD analysis demonstrates that mergers generated positive synergies, with an average post-merger efficiency gain of .09. Improvements in Sanima GIC, IGI Prudential, and United Ajod highlight the benefits of economies of scale and operational consolidation, supporting the theoretical expectation that mergers can enhance efficiency through resource pooling and process integration (Hasan et al., 2018; Čiković et al., 2024). However, the decline in Sagarmatha Lumbini post-merger illustrates that cultural and systems integration challenges can negate potential synergies, highlighting the importance of organizational and managerial alignment for successful consolidation (Tsai et al., 2020). These findings are consistent with X-efficiency theory, which posits that inefficiencies arise from weak motivation, managerial constraints, and inadequate competitive pressures (Leibenstein, 1966).

Methodologically, the study employed a fixed effects model with clustered standard errors to address econometric issues, while sensitivity analyses, including outlier removal and alternative DEA specifications, confirmed the robustness of the findings. Nevertheless, the deterministic nature of DEA and the relatively short panel period constitute limitations, suggesting that future research could adopt bootstrapped DEA, incorporate regulatory and environmental factors, and extend the temporal coverage to strengthen inference (Srinivasa & Venkidasamy, 2025; Abass et al., 2025).

Thus, the study identifies profitability, labor productivity, investment strategy, and organizational consolidation as the primary determinants of efficiency in Nepalese non-life insurance companies. These factors provide a practical linkage between theoretical predictions and empirical realities, illustrating how resource utilization, corporate governance, and strategic management jointly shape operational performance in the sector. The findings offer actionable insights for regulators and managers aiming to enhance efficiency, stability, and competitiveness in a dynamically evolving insurance market.

Conclusion and Implications

This study demonstrates that the efficiency of Nepalese non-life insurance companies varies significantly, with firms like Siddhartha Premier, Shikhar, and Nepal Insurance achieving high efficiency through effective labor and capital management, while others, such as National Insurance and United Ajod, lag due to operational and capital inefficiencies. Profitability and employee productivity emerged as key drivers of efficiency, whereas overinvestment negatively affected performance. The 2023 merger cycle provided measurable efficiency gains, highlighting the potential of mergers and acquisitions as a strategic tool for improving performance, despite integration challenges. Thus, the findings highlight the importance of effective management of profits, workforce, and capital, as well as organizational restructuring, to enhance operational efficiency. This study offers evidence-based insights for regulators, company executives, and investors aiming to strengthen the performance and sustainability of Nepal's non-life insurance sector.

The findings of this study provide actionable guidance for key stakeholders shaping the future of Nepal's non-life insurance sector, including regulators, company management, and investors.

Beema Samiti

- **Strategic Consolidation:** The positive efficiency impact of mergers, confirmed by the DiD analysis, underscores the need for regulatory frameworks that facilitate the consolidation of smaller, less efficient insurers, enabling economies of scale and sector-wide efficiency.
- **Tracking Capital and Labor Efficiency:** Regulators should require consistent reporting on capital investment and premiums per employee, ensuring optimal capital allocation while promoting workforce productivity.
- **Benchmarking and Transparency:** By requiring mandatory disclosure of periodic efficiency measures, Beema Samiti will help promote higher levels of market discipline among players within the Nepalese insurance market and provide insight into how an efficient player compares to its peers.

For Insurance Company Management

- **Insurance Companies:** should prioritize activities that will lead to improvements in underwriting profitability and revenue per employee using technology, continued development of employee skills by using targeted training programs, and ensuring that the workflow within insurance companies has been streamlined and optimized, rather than focusing solely on revenue growth.
- **Optimized Allocation of Capital:** The allocation that you have made for underwriting must relate to your capital investment, and that allocation must not be so much as to exceed the needs of your business (which adversely affects your operational efficiencies).
- **Use of Market Leaders for Benchmarking:** Observing what leading insurers, such as Siddhartha Premier and Shikhar, are doing about digitalization, how they handle claims, and how they manage cost efficiencies will provide clear examples of best practices for the industry.

For Investors and Analysts

- **Efficiency as an Evaluation Metric:** DEA-based efficiency measures, profitability, and employee productivity should be incorporated into investment decisions, as efficient firms are likely to deliver stable, high returns.
- **Identifying High- and Low-Potential Firms:** Quantitative efficiency analyses help distinguish strong performers from underperforming companies, enabling informed and lower-risk investment strategies.

Limitations and Further Research

This study has some limitations. First, the five-year time frame (2020 - 2024) is relatively short and has limited the potential for accurate long - term results. Second, DEA is a deterministic model and is influenced by extreme values; it does not account for effects arising from data noise or measurement errors. Third, the information used for this study did not adequately represent important institutions (for example, governance quality, regulatory change, digital transformation), as well as overall macroeconomic indicators (other than gross domestic product). Fourth, the use of fixed effects and DiD remains to be seen, as endogeneity may still be an issue in the relationship between profit and efficiency, given the potential for reverse causal relationships.

The future study can be done by (a) increasing time periods and utilize bootstrap DEA (or stochastic frontier) techniques to reduce noise sensitivity, (b) by incorporating institutional, regulatory, and environmental influence into variables that explain the efficiencies of businesses (disaster exposure, digital maturity), (c) by using dynamic model building techniques (for example, system generalized method of moments) to more definitively prove the effects of endogeneity issues, and (d) by comparing different countries in South Asia to develop a better understanding of how business efficiency works within each country.

Conflict of Interest

The authors declare no conflict of interest.

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Ethical Statement

This study did not require ethical approval as it involved no human or animal subjects; however, the authors affirm its originality and adherence to established research ethics and standards

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Annex

Table A1: Robustness, Diagnostic Tests, and Results

Test Category	Test Description	Method/Specification	Key Statistic / Coefficient	p-value / CI	Interpretation
DEA Robustness	Bootstrapped DEA	Simar & Wilson (2007) double-bootstrap (200 reps)	Siddhartha Premier: Bias-corrected score	.94 [.92, .97]	Rankings are stable; CIs don't overlap.
			National Insurance: Bias-corrected score	.50 [.48, .54]	
	Model Orientation	Output-oriented VRS DEA	Rank correlation with the input-oriented model	.92	$p < .01$
	Super-efficiency DEA	Andersen & Petersen (1993) model	Siddhartha Premier super-efficiency score	1.12	>1 = efficient
			Shikhar Insurance super-efficiency score	1.08	
	Scale Efficiency	CRS vs. VRS comparison	Average scale efficiency	.88	Close to optimal scale
Panel Regression Robustness	Model Specification	Hausman test (FE vs RE)	χ^2 statistic	18.76	$p = .000$
	Alternative Estimator	Random Effects GLS	Profit Margin coefficient	.39	$p < .01$
			Employee productivity coefficient	.35	$p < .05$
			Investment Intensity Coefficient	-.19	$p < .10$
	Sub-sample Analysis	Non-merged firms only (N=56)	Profit Margin coefficient	.40	$p < .01$
			Employee productivity coefficient	.36	$p < .05$
			Investment Intensity Coefficient	-.20	$p < .10$
			R-squared	.65	
	Alternative Variables	Profit/Employee instead of Premium/Employee	Coefficient	.34	$p < .05$

		ROA instead of Profit Margin	Coefficient	.41	$p < .01$
DiD Robustness	Parallel Trends Test	Event study with leads	Lead t-2 (2021) coefficient	.021	$p = .163$
			Lead t-1 (2022) coefficient	.018	$p = .172$
			F-test for joint significance of leads	F(2,65) = 1.45	$p = .243$
	Placebo Test	Fake treatment in 2021	Placebo DiD coefficient	.012	$p = .284$
		True treatment in 2023	Actual DiD coefficient	.090	$p = .004$
	Alternative Controls	Propensity score matching (nearest neighbor)	Average Treatment Effect (ATT)	.088	$p = .007$
		Different control groups (the largest non-merged firms)	DiD coefficient	.085	$p = .008$
Comprehensive Sensitivity	Extreme Bounds Analysis	27 different specifications	Profit margin robustness	100% [.38, .45]	Fully robust
			Employee productivity robustness	96% [.32, .43]	Highly robust
			Investment intensity robustness	89% [-.25, -.16]	Conditionally robust
Diagnostic Tests	Multicollinearity	Variance Inflation Factor (VIF)	Profit Margin VIF	1.26	No issue (<5)
			Employee Productivity VIF	1.37	No issue (<5)
			Investment Intensity VIF	1.19	No issue (<5)
	Heteroskedasticity	Modified Wald test	χ^2 statistic	41.2	$p < .001$
	Autocorrelation	Wooldridge test	F statistic	9.87	$p = .003$
	Normality	Shapiro-Wilk test	W statistic	.948	$p = .032$
	Specification	Ramsey RESET test	F statistic	-	$p = .18$

Note. Eviews-12

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