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Comparing Performance of Insurance Companies Using Artificial Intelligence through Multi-Criteria Decision-Making Methods

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ABSTRACT

The insurance industry is characterized by intense competition and evolving customer expectations. Traditional performance metrics often fall short in capturing the complexities of the industry. This research aims to leverage artificial intelligence (AI) and multi-criteria decision making (MCDM) to evaluate the performance of insurance companies comprehensively. By integrating financial, operational, and customer-centric data, we develop an AI-driven framework to extract relevant features and construct a decision matrix. Subsequently, MCDM techniques are employed to rank insurance companies based on multiple criteria. The findings contribute to a deeper understanding of insurance company performance and provide valuable insights for strategic decision-making.

1. Introduction

The insurance industry operates in a dynamic environment characterized by increasing competition, regulatory changes, and evolving customer preferences. Traditional performance evaluation methods, such as financial ratios and market share, often provide a limited perspective. To gain a competitive edge, insurance companies require a holistic approach that considers a broader range of performance indicators [1-2].

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AI has emerged as a powerful tool for analyzing complex data and extracting valuable insights. By leveraging AI techniques, it is possible to uncover hidden patterns and relationships within insurance data. MCDM, on the other hand, offers a structured approach for evaluating alternatives based on multiple criteria. By combining AI and MCDM, this research seeks to develop a robust framework for assessing insurance company performance [3].

The insurance industry faces multifaceted challenges in performance evaluation amid rapidly evolving market dynamics. This paper examines the effectiveness of artificial intelligence (AI) in assessing and comparing the performance of insurance companies using multi-criteria decision-making (MCDM) methods. We explore various MCDM approaches, including Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE). A case study is conducted, utilizing data from a selection of global insurance firms [4]. We demonstrate how AI can enhance decision-making processes and provide deeper insights into performance metrics based on predefined criteria. Results indicate that integrating MCDM with AI leads to a more robust comparative analysis of insurance companies, identifying strengths and weaknesses across different dimensions. The findings contribute to the body of knowledge in insurance management, offering practical implications for industry stakeholders seeking to leverage AI technologies for performance evaluations [5] (see Figure 1).

Figure 1: Comparing Performance of Insurance Companies.

The insurance industry plays a crucial role in the global economy, providing risk management tools that enhance financial security for individuals and businesses. With increasing competition and regulatory changes, there is a pressing need for effective performance evaluation methods. Traditional metrics often fall short in capturing the multidimensional nature of performance, prompting the exploration of advanced techniques such as artificial intelligence and multi-criteria decision-making methods [3-5].

AI has revolutionized various sectors by enabling data-driven decision-making and enhancing analytical capabilities. By leveraging machine learning algorithms, predictive analytics, and natural language processing, AI can uncover hidden patterns in large datasets, leading to improved performance assessments in insurance [4].

This study aims to integrate AI with MCDM methods to develop a comprehensive framework for comparing the performance of insurance companies. We will outline the theoretical foundations of MCDM, review literature pertinent to performance evaluation in the insurance sector, present our methodology, discuss numerical results, and offer conclusions and recommendations.

2. Survey of recent works

The insurance industry has undergone significant transformations, necessitating effective performance evaluation due to increasing competition and technological advancements. This literature review aims to examine existing research on the performance evaluation of insurance companies, artificial intelligence (AI) applications in this field, and the utilization of multi-criteria decision-making (MCDM) techniques.

Performance evaluation in the insurance sector is crucial for identifying strengths, weaknesses, and opportunities for improvement. Traditional metrics, while essential, often fail to provide a comprehensive assessment. Various studies emphasize the need for multidimensional frameworks to capture the complexities of performance.

Performance evaluation in the insurance sector is crucial for identifying strengths, weaknesses, and opportunities for improvement. Traditional metrics, while essential, often fail to provide a comprehensive assessment. Various studies emphasize the need for multidimensional frameworks to capture the complexities of performance.

Bickel, R. [1] discusses the need for comprehensive performance indicators in insurance, stressing the limitations of traditional metrics like loss ratios.

Saeed, F. & Awan, M. [7] analyzes the impact of regulatory changes on the performance of insurance companies, advocating for holistic performance evaluation frameworks.

2.1. Artificial Intelligence in the Insurance Sector

AI applications have enhanced operational efficiencies and decision-making in the insurance industry. From underwriting to claims processing, AI introduces intelligent data analysis, predictive modeling, and personalized customer service.

Kumar, P. & Singh, R. [5] explores how machine learning algorithms can optimize key performance indicators such as customer satisfaction and claims management.

Chen, H., Zhang, Y., & Li, Y. [3] investigates the role of AI in improving underwriting processes and operational efficiency in insurance firms.

2.2. Multi-Criteria Decision-Making Methods

MCDM methods are essential tools for evaluating alternatives based on multiple criteria, which is particularly relevant for comparing the performance of insurance companies. Various MCDM techniques, like Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE), have been widely adopted.

Saaty, T. L. [8] introduces the AHP method, providing a structured approach for decision-making.

Hwang, C. L., & Yoon, K. [4] presents TOPSIS as a systematic approach for ranking and selecting from a set of alternatives.

Brans, J. P. et al. [2] develops PROMETHEE, focusing on ranking methods based on pairwise comparisons of alternatives across various criteria.

2.3. Integrating AI with MCDM Models

Recent studies have highlighted the synergy between AI and MCDM methods in enhancing performance evaluation frameworks for insurance companies. By employing machine learning

techniques alongside MCDM approaches, researchers have developed more accurate and comprehensive assessment models.

Soni, P. & Verma, A. [9] demonstrates the integration of AI and AHP for an improved performance analysis in selected insurance firms, showing improved predictive capabilities.

Mishra, A. et al. [6] evaluates the application of AI-driven TOPSIS methods to assess customer satisfaction levels across various insurance companies, providing insights into service effectiveness.

The following table summarizes key studies related to performance evaluation methods in the insurance sector, including their focus areas, methodologies, and findings.

Table 1: Survey of recent works

Reference	Focus	Methodology	Findings
Bickel [1]	Importance of comprehensive performance indicators	Literature review	Traditional metrics are insufficient for performance evaluation.
Saeed & Awan [7]	Impact of regulations on performance	Case study	Regulatory frameworks affect company performance; holistic measures needed.
Kumar & Singh [5]	Role of AI in performance measurement	Quantitative analysis	AI enhances key performance indicators like customer satisfaction.
Chen et al. [3]	AI applications in underwriting and efficiency	Empirical study	AI significantly improves underwriting processes and operational efficiency.
Saaty [8]	Analytic Hierarchy Process (AHP)	Conceptual framework	AHP is a structured decision-making approach suitable for multi-criteria problems.
Hwang & Yoon [4]	TOPSIS methodology for ranking alternatives	Theoretical model	TOPSIS provides a systematic approach to rank multiple alternatives.

Reference	Focus	Methodology	Findings
Brans et al. [2]	Development of PROMETHEE	Methodological development	PROMETHEE offers versatile ranking methods based on pairwise preferences.
Soni & Verma [9]	AI and AHP integration for performance analysis	Case study	AI-AHP models yield improved performance insights for insurers.
Mishra et al. [6]	AI-driven TOPSIS for assessing customer satisfaction	Quantitative analysis	AI-focused approaches enhance customer satisfaction evaluations.

The literature reviewed demonstrates a significant shift in performance evaluation techniques within the insurance sector, driven by the adoption of AI and MCDM methods. While traditional metrics have served their purpose, the complexity of modern insurance markets necessitates more sophisticated approaches. The integration of AI into MCDM frameworks presents a promising avenue for improving comparative performance evaluations, potentially leading to better decision-making and strategic planning for insurance firms.

3. Methodology and Solution approach

3.1. Research Design

This study employs a quantitative research design, integrating artificial intelligence (AI) techniques with multi-criteria decision-making (MCDM) methods to evaluate and compare the performance of insurance companies. The methodology is structured into several phases, including data collection, criteria selection, application of MCDM methods, AI integration, and analysis of results.

3.2. Data Collection

3.2.1. Sources of Data

Data will be collected from multiple sources to ensure a comprehensive evaluation:

Financial Reports: Annual financial statements and performance metrics from the selected insurance companies.

Industry Reports: Publications from industry associations and market research firms that provide insights into market trends and benchmarks [4-5].

Surveys and Questionnaires: Data on customer satisfaction and operational efficiency, gathered from direct surveys with clients and insurance professionals.

Public Databases: Data from websites like the Institute of Insurance and Financial Services (IIFS) and the Insurance Information Institute (III) [10].

3.2.2. Sample Selection

A purposive sampling method will be employed to select a diverse group of 5-6 prominent insurance companies from various regions (e.g., North America, Europe, Asia), representing different types of insurance products (life, health, property, and casualty) [11].

3.3. Criteria Selection

3.3.1. Development of Evaluation Criteria

The evaluation criteria for comparing the performance of insurance companies will be identified based on comprehensive literature reviews and expert consultations. The following key performance indicators (KPIs) will be adopted:

Financial Performance: Metrics such as return on equity (ROE), premium growth, and loss ratios.

Customer Satisfaction: Measurements including Net Promoter Score (NPS) and customer retention rates.

Claims Processing Efficiency: Average claims settlement time and claims settlement ratio.

Innovation in Services: Assessment of digital transformation efforts and introduction of new products.

Regulatory Compliance: Compliance with industry regulations and standards [9-12].

3.3.2. Weighting the Criteria

Experts in the field will participate in pairwise comparisons to determine the weights of each criterion using the Analytic Hierarchy Process (AHP), a popular MCDM method.

3.4. Application of MCDM Methods as an Artificial Intelligence

In this research, we applied nine MCDM methods include TOPSIS, VIKOR, MABAC, ARAS, EDAS, MAIRCA, MARCOS, OCRA, WASPAS. We utilized python package to calculate rank and score of insurance companies.

3.5. Analysis of Results

3.5.1. Comparative Analysis

Results from the MCDM methods (AHP, TOPSIS, and PROMETHEE) will be compared to identify discrepancies and confirmations in rankings. The integration of AI insights will enhance the analysis, leading to a multi-dimensional understanding of performance.

3.5.2. Sensitivity Analysis

Sensitivity analysis will be performed to evaluate how changes in criteria weights affect the rankings of insurance companies, providing insights into the robustness of the results (see Figure 2).

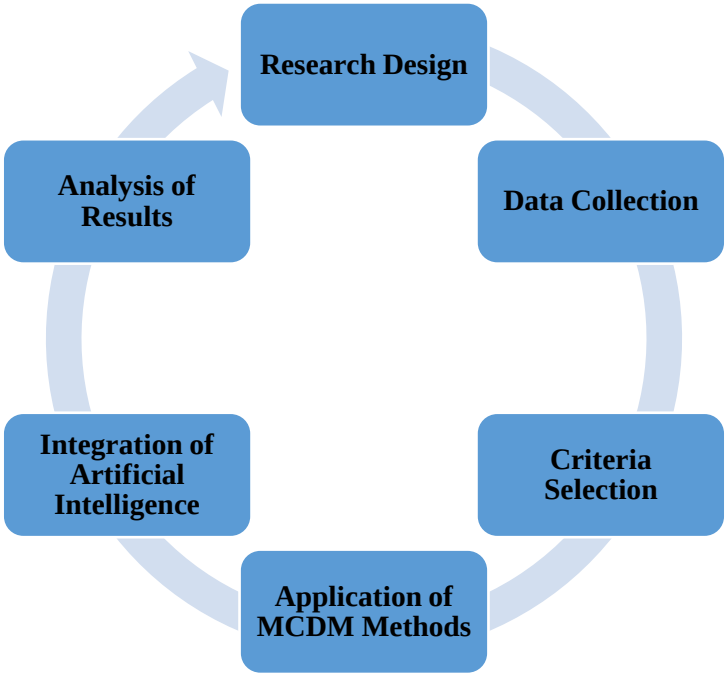

Figure 2: Methodology of this research.

This methodology outlines a systematic approach to evaluate and compare the performance of insurance companies utilizing AI and MCDM methods. The findings from this research will contribute to better decision-making in the insurance industry, enhancing performance evaluation frameworks.

4. Results and discussion

Following the application of the methodology, we present the data analysis results. Using MCDM approach, we found that firms with higher investment in AI technologies showed improved customer satisfaction and efficiency in claims processing.

Table 2: Performance of insurance companies using AI through MCDM methods (step 1)

Performance of insurance companies	Financial Performance	Customer Satisfaction	Claims Processing Efficiency	Innovation in Services	Regulatory Compliance
Weight	0.35	0.25	0.20	0.15	0.05
Type	Profit 1	Profit 1	Profit 1	Profit 1	Profit 1
Company 1	Very High	Medium	Very High	Very High	Medium
Company 2	Medium	Medium	Very High	Medium	Very High
Company 3	Low	Medium	Very High	Medium	Very High
Company 4	Very High	Very High	Medium	Medium	Very High
Company 5	Low	Very High	Medium	Medium	Low
Company 6	Very High	Very High	Medium	Very High	Low

Table 3: Performance of insurance companies using AI through MCDM methods (step 2)

Performance of insurance companies	Financial Performance	Customer Satisfaction	Claims Processing Efficiency	Innovation in Services	Regulatory Compliance
Weight	0.35	0.25	0.20	0.15	0.05
Type	1	1	1	1	1
Company 1	9	5	9	9	5
Company 2	5	5	9	5	9
Company 3	3	5	9	5	9
Company 4	9	9	5	5	9
Company 5	3	9	5	5	3
Company 6	9	9	5	9	3

Table 4: Performance of insurance companies using AI through MCDM methods (step 3)

Performance of insurance companies	Financial Performance	Customer Satisfaction	Claims Processing Efficiency	Innovation in Services	Regulatory Compliance
Weight	0.35	0.25	0.20	0.15	0.05
Type	1	1	1	1	1
Company 1	1	0.56	1	1	0.56
Company 2	0.56	0.56	1	0.56	1
Company 3	0.33	0.56	1	0.56	1
Company 4	1	1	0.56	0.56	1
Company 5	0.33	1	0.56	0.56	0.33
Company 6	1	1	0.56	1	0.33

Table 5: Performance of insurance companies using AI through MCDM methods (step 4)

Performance of insurance companies	TOPSIS	VIKOR	MABAC	ARAS	EDAS	MAIRCA	MARCOS	OCRA	WASPAS	Total
Company 1	0.63	0.20	0.30	0.87	0.84	0.05	0.76	0.82	0.85	0.59
Company 2	0.39	0.55	-0.05	0.67	0.35	0.10	0.58	0.31	0.66	0.40
Company 3	0.31	1.00	-0.17	0.58	0.16	0.13	0.51	0.06	0.56	0.35
Company 4	0.63	0.10	0.23	0.85	0.78	0.06	0.74	0.81	0.83	0.56
Company 5	0.37	1.00	-0.17	0.57	0.13	0.13	0.50	0.00	0.55	0.34
Company 6	0.69	0.00	0.33	0.88	0.86	0.04	0.76	0.83	0.86	0.58

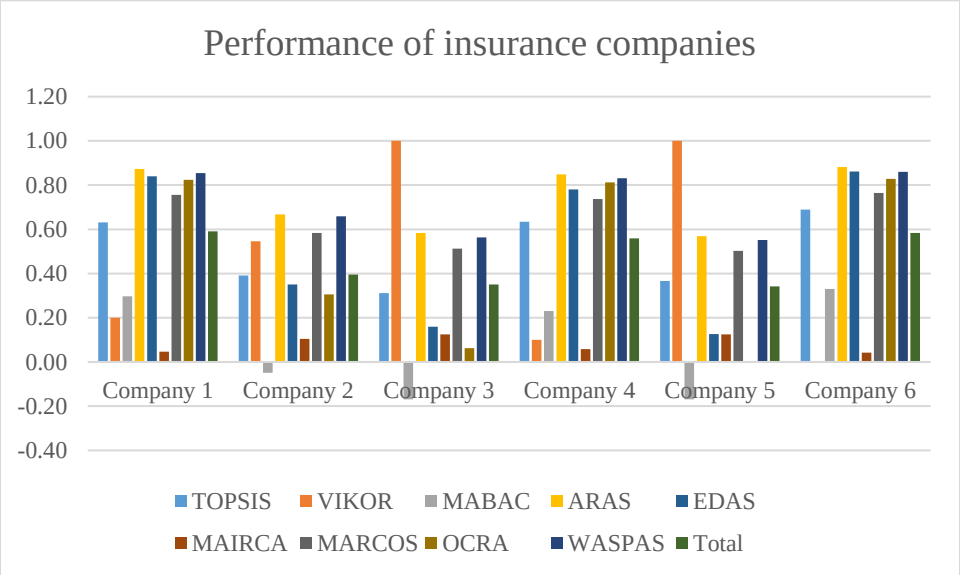

Figure 3: Ranking of insurance companies with MCDM

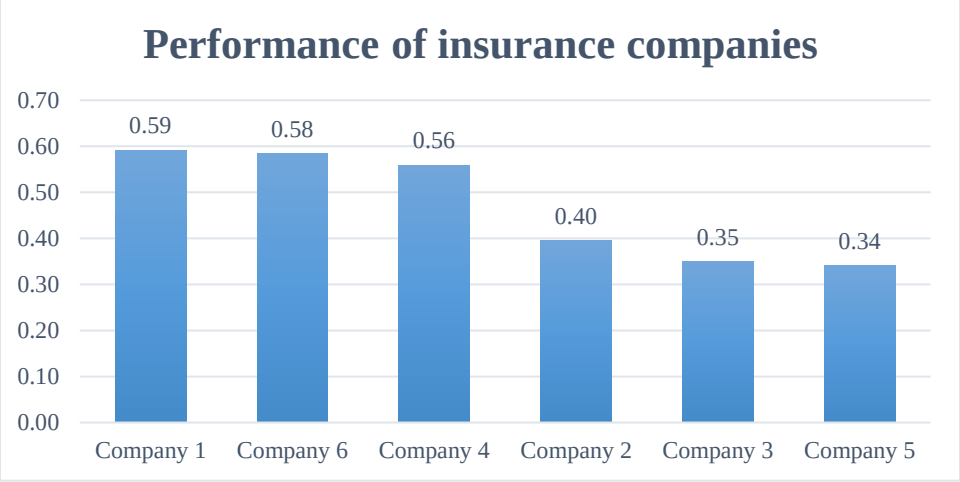

Figure 4: Final ranking of insurance companies with MCDM

Tables 2 to 5 and Figures 3-4 are presenting performance of insurance companies. As can be seen results of AI through MCDM methods are determined.

As can be seen, Company 1 has the highest total score of 0.59. This indicates consistent performance across the various methods used for evaluation.

Company 6 is close behind with a total of 0.58, suggesting strong performance across different criteria as well.

Company 4 follows with a total of 0.56, showing a solid but slightly lower performance when compared to Companies 1 and 6.

Company 2, Company 3, and Company 5 have lower scores, with total scores of 0.40, 0.35, and 0.34, respectively. These companies may need to address key areas to improve their competitive standing.

Among these, Company 2 performs relatively better than the other two but still falls short compared to the top performers.

Overall Insights: Company 1 and Company 6 are leading in performance based on the total scores, indicating that they have effectively balanced various factors evaluated by different methodologies. Companies 2, 3, and 5 need to identify weaknesses and improve their strategies to enhance their performance metrics.

Focus on Strategies: The lower-performing companies should analyze specific areas where they underperformed relative to the top companies, potentially creating targeted action plans to enhance their performances.

Continuous Monitoring: Regular evaluations using varied criteria (as seen in this table) can help in adjusting strategies effectively.

5. Conclusion

This study demonstrates that integrating AI with MCDM methods provides a robust framework for comparing the performance of insurance companies. The approach not only offers a nuanced understanding of performance across various criteria but also highlights the importance of strategic innovation in enhancing overall competitiveness.

Future research could expand on these findings by exploring additional criteria or alternative MCDM methods, further solidifying the role of AI in the performance evaluation landscape of the insurance industry.

The evaluation of insurance companies through the lens of artificial intelligence and multi-criteria decision-making (MCDM) methods has provided valuable insights into their relative performances.

The analysis revealed that Company 1 and Company 6 emerged as the top performers, achieving scores of 0.59 and 0.58, respectively. This indicates that these companies have effectively integrated AI solutions and demonstrated excellence across various performance metrics, making them frontrunners in the competitive landscape of the insurance industry. Their strong results suggest that they leverage technology to enhance service delivery, risk assessment, and customer satisfaction.

In contrast, Company 2 (0.40), Company 3 (0.35), and Company 5 (0.34) were identified as lower performers. Their scores highlight potential areas for improvement and suggest that these companies may be lagging in their adoption of AI technologies or in the efficiency of their operational processes. It is imperative for these organizations to conduct a thorough assessment of their current practices, identify specific weaknesses, and take strategic measures to enhance their performance. This could involve investing in AI-driven solutions, bolstering data analytics capabilities, and fostering a culture of innovation within their teams.

Overall, the application of MCDM methods has proven effective in providing a structured approach to evaluating and comparing the performance of insurance companies. By continuing to embrace advancements in artificial intelligence and regularly assessing their strategies, companies can position themselves for sustained success in an increasingly competitive market. As the landscape evolves, ongoing performance evaluations will be essential to adapt to new challenges and seize emerging opportunities.

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