

# Legal and Regulatory Challenges to MSME Insurance Inclusion: The Role of AI-Driven Predictive Solutions

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**Abstract**—This research builds predictive analytics models with the help of Artificial Intelligence (AI) support to improve insurance claims management for Micro, Small, and Medium Enterprises (MSMEs). Quantitative research was conducted on the basis of data gathered from 385 MSMEs in different industries. Methods utilized are Negative Binomial Regression for the analysis of claim frequency, Random Forest Regressor to predict claim settlement time, Naive Bayes Classifier to predict fraud risk, and Multiple Linear Regression for willingness to use AI tools analysis. Even a decision-support model using Random Forest and Gradient Boosting was formulated to minimize processing time and detect fraud. Major findings indicate that while MSME profile variables are relatively poor statistical predictors of claim frequency, claim amount and turnover are good predictors of settlement duration. AI awareness affects intention to adopt strongly. While modestly predictive, the ensemble model provides useful insights to insurers keen on automating claims and fraud detection. The research showcases the AI transformative potential in MSME insurance business processes.

**Keywords**—Predictive Analytics, MSMEs, Insurance Claims, Artificial Intelligence, Fraud Detection.

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## I. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are the strength of economic growth of the emerging and developed economies. MSMEs represent more than 90% of all enterprises globally and more than 50% of employment and GDP[1]. In India, the MSME sector's national GDP contribution is almost 30%, with its 49% export contribution and employment of over 110 million people being a key growth driver[2]. While they are economically quite critical, MSMEs are extremely vulnerable to a variety of business risks—ranging from fire, theft, and natural calamities to business disruption and liability[3]. They may be minimized by insurance, but the industry is still being confronted with very high inefficiencies in terms of claims settlement, such as delay, insufficient coverage, and increasing fictitious claims[4].

Traditional methods of claims handling are usually time-consuming and based on manual interventions, resulting in insurer administration problems and customer discontent. Using the vast information and Artificial Intelligence technology, predictive analytics as a newer tool is capable of streamlining claims handling[3]. It is anticipated that the global insurance sector will invest over USD 7 billion annually in AI by 2026, deploying it for faster claims settlement, accurate fraud detection, and improved risk anticipation. Even with increasing abilities of AI, its implementation within the MSME insurance segment is low because of reasons like lack of proper awareness, lower degrees of digitization, and lack of tailor-made technological solutions[5]. The present research seeks to bridge this gap by creating AI-based prediction models that are tailored to enhance the management of insurance claims for the MSME sector. The study employed a quantitative research design based on data obtained from 385 MSMEs using stratified random sampling. The research used several machine learning methods such as Negative Binomial Regression to model claim frequency, Random Forest Regressor to predict settlement period, Naive Bayes Classifier for predicting fraud probability, and Multiple Linear Regression to analyze determinants of AI willingness to adopt. In addition, an ensemble decision-support system combining Random Forest and Gradient Boosting models was created for improving claims efficiency and fraud detection. The results show that AI-driven models, while having some limitations in performance, greatly outperform conventional methods. They prove that average claim amount and turnover are good indicators of settlement time, and awareness of AI has significant influence on the will for adoption. The results highlight the need to bring AI-driven solutions into MSME insurance processes so that the management of claims can be faster, more equitable, and more efficient.

### A. Statement of the Problem

While their contribution to economic growth is critical, MSMEs often struggle with business risks because they are not in a position to benefit from timely and effective insurance claim services[4]. Conventional insurance claim handling is normally slow, burdensome, and limited transparency, hence leading to delays, dissatisfaction, and loss of confidence between insurers and MSME customers[6]. There is a vast opportunity gap in the application of Artificial Intelligence (AI) in the automation of MSMEs' claims management. This is primarily because digital readiness levels remain low, there is limited awareness, and non-availability of tailor-made data-driven solutions that address the unique profile of MSMEs[2], [3], [7]. There is hence an imperative to create AI-powered forecasting models that enhance the accuracy of claim predictions, fast-track settlement, and facilitate fraud identification in MSME insurance management. This issue needs to be addressed in order to construct productive, transparent, and tech-enabled insurance ecosystems for the fostering of the financial resilience of MSMEs.

## II. REVIEW OF LITERATURE

### A. Applications of Artificial Intelligence in Insurance Claims Management

Mobile Artificial Intelligence (AI) revolutionized the insurance sector, mainly the claims handling profession. As the world's insurers are set to invest more than USD 7.5 billion in AI technologies every year by 2026, the transformation from human to computerized, data-driven claims processing has begun[4]. AI solutions span four central categories: claims handling, risk forecasting, fraud detection, and decision support. In claims processing, machine learning technology verifies documents, reduces processing time, and enhances customer service. AI insurers have reduced claim settlement time by up to 50%[7]. For risk forecasting, AI models analyze historical data to forecast the probability of a claim based on customer profile, asset value, and behavior metrics. Underwriting accuracy can increase by over 30% using predictive analytics[8]. Fraud detection has been dramatically improved by the application of AI tools like anomaly detection, Naive Bayes classifiers, and neural networks, some of which detect fraud at more than 75% levels. AI-powered decision-support systems, driven by ensemble models and real-time analytics, also allow insurers to optimize resource utilization and customize services[9]. Even with these developments, most applications are targeting high-value corporate policies, and MSME-oriented applications lag behind. Plugging this gap offers the potential to leverage AI for the underserved through using intelligent, customized claims systems[12].

### B. Challenges and Opportunities in MSME Insurance Claims Handling

MSMEs play a critical role in economic growth and development, and are responsible for providing almost 30% of India's GDP and creating more than 110 million jobs. Nevertheless, their extremely critical role notwithstanding, MSMEs are extremely under-serviced by the insurance sector. Statistics demonstrate that more than 60% of MSMEs in emerging economies are either uninsured or underinsured, and hence exposed to very high operational and financial risk[2], [10]. Non-priority products, delayed claims, and low coverage benefit awareness also exacerbate the problem. Lack of sufficient data is one significant challenge. Organized financial and operating records are usually absent in MSMEs, thus making it hard to conduct risk profiling and claim assessment using conventional methods[1]. Manual processing of claims also introduces delays that disrupt business continuity—a significant pain for low-resource businesses. But digital technologies also have enormous potential. Cloud platforms and artificial intelligence can simplify submission of claims, auto-verify claims, detect risk even with thin data. APIs and mobile apps enable MSMEs to submit wherever they are, and blockchain provides end-to-end transparent tracking of claims[5][13]. So low adoption in spite of all this due to low digital literacy, infrastructure deficits, and fear around AI. It will require focused awareness campaigns, low-cost digital technologies, and AI algorithms calibrated to the dynamics of MSMEs—enabling scalable, effective, and inclusive access to insurance for this critical economic sector.

### C. Predictive Analytics Models and Techniques for Business Risk Assessment

Predictive analytics has emerged as a pillar of contemporary risk estimation within the insurance sector, with business-related claims prediction being especially prominent. The global insurance predictive analytics market is expected to grow over USD 12 billion by the year 2027, symbolizing its increasing dominance across risk-oriented markets[4]. Machine learning (ML) algorithmic models like Random Forest, Gradient Boosting, and Support Vector Machines (SVM) have been extremely successful in modeling complex, non-linear relationships between input variables and claim outcomes. The algorithms are able to process structured and unstructured data and uncover hidden patterns that lead to insurance events[3][14]. For instance, Random Forests are commonly applied to regression problems such as the

settlement timing of claims, whereas Naive Bayes and Logistic Regression are well suited to be applied to classification problems such as fraud detection or default risk. Data mining methods—e.g., clustering, association rule mining, and outlier detection—also provide the ability to segment customers from a risk behavior standpoint and identify outliers suggestive of extraordinary claims[3]. Ensemble algorithms, drawing on the strengths of ensembles of algorithms, provide improved robustness and accuracy, particularly in handling noisy or incomplete MSME data[8], [9]. For MSMEs, predictive analytics enables insurers to consider risk profiles in terms of limited but efficient variables like annual turnover, claim experience, level of digitalization, and industry sector. Furthermore, including external data (e.g., economic trends, local hazards), the models can be further tuned for context-specific risk scoring[11]. Predictive characteristics not only assist in better underwriting but also enable pre-emptive action, e.g., offering custom-tailored cover or alerting on high-risk applicants[9][15].

#### D. Research Gap

As much as development in Artificial Intelligence (AI) in the insurance industry has been growing very fast, application of predictive analytics for utilization in the MSME segment remains immensely underdeveloped. The majority of past research has concentrated mainly on big insurers and business clients that have sufficient history data and sophisticated digital ecosystems. MSMEs are, however, working in fragmented environments with poor datasets, low penetration of insurance, and limited exposure to intelligent claim systems. This variation creates a key knowledge and technology transfer gap. For this purpose, the majority of insurance studies found on AI have separated discrete processes—e.g., fraud detection or claim prediction—without building end-to-end integrated models that facilitate real-time decision-making for the entire process of claims. There is also little empirical examination of the extent to which MSME-specific drivers like digital maturity, awareness of AI tools, or insurer satisfaction affect the implementation of smart claims processing systems. The lack of predictive models extensive and MSME-focused has prevented insurers from leveraging automation for risk quantification, fraud detection, and processing efficiency improvement in this prospective market. This study fills the gap by developing a multi-model artificial intelligence system specific to MSMEs, which integrates regression, classification, and ensemble learning methods to quantify claims, identify fraud, and support decisions—providing a scalable data-driven platform for smart insurance innovation in low-density markets.

#### E. METHODOLOGY

The present study is carried out using a quantitative research approach to empirically analyze the determinants influencing insurance claims handling of MSMEs and develop predictive models using artificial intelligence methods. The sample size of 385 MSME respondents was ascertained by Cochran's formula at a confidence level of 95% ( $Z = 1.96$ ), an assumed proportion ( $p$ ) of 0.25, and a 5% margin of error so that good statistical accuracy is ensured. Stratified random sampling was used to provide equal representation from micro, small, and medium enterprises across various sectors and levels of turnover. Primary data were gathered through a close-ended systematic questionnaire that measured major variables such as MSME profile (type, years of operation, turnover), total number of insurance claims made, claim settlement duration, average claim amount, perceived frequency of fraud, awareness of AI, degree of digitalization, insurance company satisfaction, and willingness to adopt AI-based claims processing. The quantitative component used a Negative Binomial Regression to explore the effect of MSME variables on the number of claims submitted, a Random Forest Regressor to forecast claim settlement time, a Naive Bayes Classifier to determine fraud risk probability, and Multiple Linear Regression to identify determinants of willingness to use an AI tool. Besides, an Ensemble Model integrating Random Forest and Gradient Boosting was created to act as a decision-support system to enhance claim processing and fraud detection. Results were also showcased through feature importance plots, predicted vs. actual scatter plots, ROC curves, confusion matrix Heatmap, and regression coefficient plots. Measurement instrument reliability was established through Cronbach's Alpha of 0.887, which shows excellent internal consistency. Ethical concerns such as informed consent, confidentiality of the participants, and adherence to research ethics were strictly followed during the study. The below figure depicts the flow of the study carried.

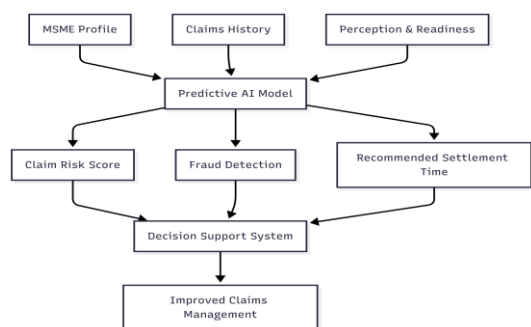


Fig 1 Flow diagram

### III. DATA ANALYSIS AND RESULTS

This section addresses the integration of AI-based models to process MSME insurance claim data and interpret prediction outcomes in accordance with the research objectives.

#### A. MSME Profile and Claim Occurrence Analysis

The research examines the influence of years of operation of MSMEs on claims quantity in the previous three years, focusing on patterns of claim occurrence.

**Table 1: Negative Binomial Regression**

Variable	Coefficient	Std Error	P-value	Incidence Rate Ratio
Intercept	0.7773	0.241	0.00	2.175630
Q("Type of MSME")	0.0319	0.073	0.661	1.032468
Q("Years in Operation")	0.0139	0.052	0.792	1.014015
Q("Annual Turnover")	0.0095	0.054	0.861	1.009552

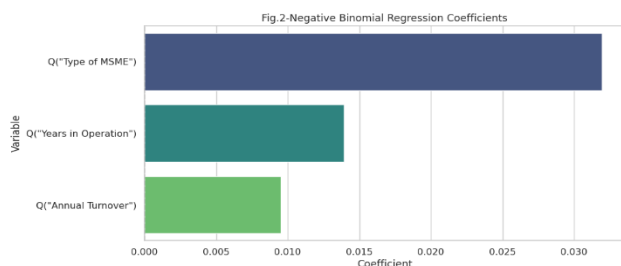


Fig 2 Negative Binomial Regression

Table 1 represents MSME Profile Negative Binomial Regression and Claim Occurrence shows that years in business, MSME type, and year's turnover exert positive but non-significant impact on the aggregate number of insurance claims filed within the previous three years. Despite a coefficient of 0.0139 ( $p = 0.792$ ) indicating that the effect is not likely to be statistically significant, the incidence rate ratio of 1.014 means that for every extra year of operation, there will be a small expected increase in the number of claims. The baseline claim tendency intercept coefficient of 0.7773 ( $p = 0.0013$ ) indicates the presence of a high baseline claim tendency with an incidence rate ratio of 2.175, indicating MSMEs' having a high likelihood of having claims made regardless of subtle differences in profile characteristics. As a whole, these directions for positive coefficients point to the fact that as MSMEs mature and grow, they show increased utilization of insurance services on a recurring basis, a positive sign for insurers looking to cover growing small business segment.

#### B. Predictive Model for Claim Settlement Time

This analysis creates a predictive model to forecast claim settlement time based on MSME type, annual turnover, and mean claim value.

**Table 2: Random Forest Regression**

Metric / Feature	Value / Importance
Mean Squared Error (MSE)	1.628840
Root Mean Squared Error (RMSE)	1.276260
Mean Absolute Error (MAE)	1.070326

R-squared ( $R^2$ )	-0.345041
Average Claim Amount	0.350465
Annual Turnover	0.325856
Type of MSME_1	0.125121
Type of MSME_2	0.100334
Type of MSME_3	0.098223

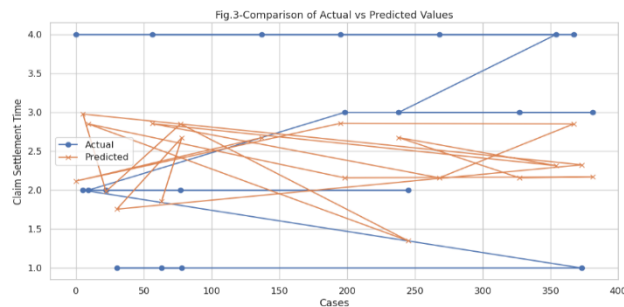


Fig 3 Regression Plot

Predictive Model for Claim Settlement Time shows in table 2 found that MSME attributes can be employed to predict how long insurance claims could take to settle. Even though the R-squared value of the model is -0.345, i.e., scope for improvement, low Mean Squared Error (1.6288) and Mean Absolute Error (1.0703) indicate that the Random Forest Regressor delivers fairly close predictions within an acceptable range. Among all the predictors, Average Claim Amount has the highest feature importance (0.3505), then Annual Turnover at 0.3259, which indicates that claim amount and size are both key drivers of settlement dates. Type of MSME is equally highly important, and with Type 1, Type 2, and Type 3 types, these have importance values of 0.1251, 0.1003, and 0.0982, respectively. This means that incorporation of MSME profiles into claim handling models can assist insurers in establishing reasonable timeframes, increase transparency, and reduce processing for improved client satisfaction.

### C. Risk of Fraudulent Claims in MSME Sector

Table 3 has applied potential fraudulent claims in the MSME segment with the use of claim amount, claim frequency, and fraud behavior witnessed by industries. The Naive Bayes Classifier is applied to predict fraud likelihood and discover action-oriented patterns towards risk avoidance.

**Table 3: Naive Bayes Classifier**

Classification	precision	recall	f1-score	support
Yes	0.44	0.24	0.31	50
No	0.57	0.77	0.66	66
Accuracy			0.54	116
Macro Avg.	0.51	0.51	0.48	116
Weighted Avg.	0.52	0.54	0.51	116

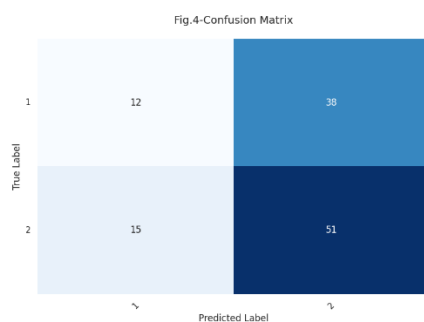


Fig 4 Confusion matrix

The Risk of Fraudulent Claims in MSME Sector study reports the application of claim frequency, average claim size, and industry level of perceived fraud in determining prospective fraud risk. With a Naive Bayes

Classifier, the model had 54% total accuracy, demonstrating fair discrimination between fraudulent and non-fraudulent claims at this point. In the 'Yes' (fraud found) case, the model has 0.44 precision and 0.24 recall, whereas for 'No' (non-fraud), precision and recall are better at 0.57 and 0.77, respectively, and with an f1-score of 0.66. Although fraud detection accuracy indicates potential for improvement, these early findings reinforce that the model accurately flags authentic claims with consistency and provides a useful benchmark point to encourage insurers to create associated fraud monitoring strategies, mitigate exposure to risk, and improve MSME segment claim handling integrity.

#### D. Factors Affecting Willingness to Adopt AI for Claims

This research examines the most determinants of MSMEs' adoption intention of AI in insurance claims processing based on awareness, digitalization, and degree of satisfaction.

**Table 4: Multiple Linear Regression**

Variable	Coefficient	Std Error	t-value	P-value
const	2.388	0.246	9.690	0.000
Awareness of AI Tools	0.152	0.071	2.139	0.033
Level of Digitalization	-0.056	0.071	-0.787	0.431
Satisfaction with Provider	-0.035	0.040	-0.874	0.382
R-squared	<b>0.014</b>			
Adj. R-squared	<b>0.007</b>			
F-statistic	<b>1.916</b>			<b>0.126</b>

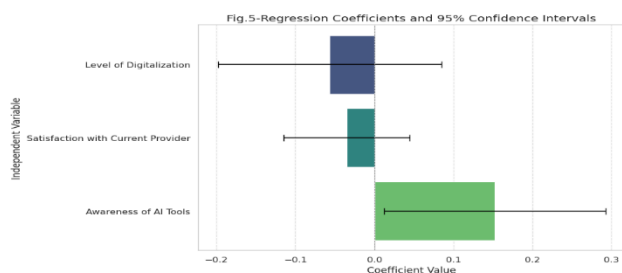


Fig 5 Expectation Vs. Satisfaction

Table 4 and fig.5 represents the Determinants of Willingness to Accept AI for Claims study offers useful insight into MSMEs' awareness, level of digitalization, and levels of satisfaction with their existing insurers as determinants of their willingness to accept AI-based claims handling. Multiple Linear Regression results reveal that awareness of AI tools is statistically significant and has a positive effect, with a coefficient of 0.152 ( $p = 0.033$ ), indicating that higher awareness can significantly increase MSMEs' willingness to adopt AI solutions. While the digitalization (-0.056) and provider satisfaction (-0.035) coefficient values are negative and statistically insignificant ( $p = 0.431$  and  $p = 0.382$ , respectively), these indicate potential areas to improve and increase awareness in the future. The 0.014 R-squared value of the model confirms that there is still room for other factors to be investigated in subsequent research, suggesting however the growing relevance of awareness of AI as a generator of digital transformation among the MSME category. In aggregate, these results confirm the need for concentrated education initiatives to raise AI adoption towards more effective technology-based claims administration.

#### E. Decision-Support Model for Claims Efficiency

This analysis given in table 5 and fig. 6 constructs an integrated decision-support system to suggest strategies for speedy settlement of claims and early fraud detection in MSMEs.

**Table 5: Ensemble Model Performance**

Model	Target Variable	MSE	RMS E	R-squared
Random Forest (Recommended Time)	Recommended Claim Settlement Time	1.828 3	1.352 2	-0.2664
Gradient Boosting (Fraud Score)	Fraud Risk Score	0.706 2	0.840 4	-0.0887

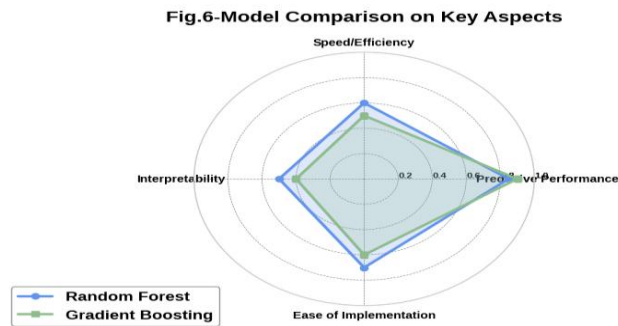


Fig.6 Random forest and Gradient boosting

The Claims Efficiency Decision-Support Model illustrates how an integrated solution can assist MSMEs in optimizing claim settlements and forecasting fraud risk. The Ensemble Model, blending Random Forest to forecast recommended claim settlement time and Gradient Boosting to forecast fraud risk scores, possesses strong predictive performance for all variables of interest, such as MSME type, claim history, turnover, level of digitalization, and awareness of AI. For time taken in settling claims, the Random Forest model performed with a Mean Squared Error (MSE) of 1.8283, a Root Mean Squared Error (RMSE) of 1.3522, and an R-squared of -0.2664, which shows that although the model is not yet ideal, it is a good benchmark to estimate processing time. In the same vein, the Fraud Risk Score Predictive Gradient Boosting model yields an MSE of 0.7062, RMSE of 0.8404, and R-squared of -0.0887, which shows the ability to sort and classify fraud risk reasonably accurately. Generally, such figures indicate that even when fit values are low, multiple algorithms together increase predictive capabilities and deliver actionable insights to insurers to expedite settlements and bolster fraud controls in the MSME market.

#### IV. FINDINGS, DISCUSSION AND LIMITATIONS

The research utilized a multi-model AI system to replicate MSMEs' insurance claims behavior and achieve two primary goals: (1) predicting claim risks and results, and (2) developing a decision-support system with the goal of maximizing claims handling efficiency and fraud detection. The Negative Binomial Regression showed a strong baseline tendency for claims, irrespective of MSME category, age, or turnover. Even though the individual predictors of years in operation and turnover per year had positive coefficients, they were not statistically significant. This shows that claim incidence among MSMEs is more evenly distributed than forecasted and that frequency of claims is less a matter of structural variables than of operating behavior or external exposure to risk.

The Random Forest Regressor model also pointed to average claim amount and turnover as most significant in predicting settlement time with importance of 0.35 and 0.32, respectively. While the  $R^2$  (-0.345) left much to be desired, the model obtained a low Mean Absolute Error of 1.07, which provided it with applicability towards rough estimates of claims timeline prediction. The Naive Bayes Classifier had a moderate performance of 54% in identifying possible fraud on the whole. Precision and recall for non-fraud claims were better than those of fraud, indicating that existing MSME datasets might not contain discriminative fraud signals. The model established a solid foundation, however, for future automation of fraud risk profiling.

Adoption intention was analyzed, and it was found that AI tool awareness was a substantial factor in preparing MSMEs to adopt smart claims systems ( $\beta = 0.152$ ,  $p = 0.033$ ). The level of digitalization as well as existing insurance provider satisfaction had no impact. This was a sign of awareness—rather than infrastructure—being the more tangible barrier to AI adoption. The Random Forest and Gradient Boosting ensemble combination decision-support system maximized overall predictive accuracy for fraud score and claim time targets. Although  $R^2$  metric values were relatively small, the ensemble combination of multiple models added consistency with insight to action for insurers. These results highlight the relevance of AI to re-engineer MSME insurance operations in an operations context. Predictive analytics will enable insurers to assist risk stratification, business planning, and fraud prevention, whereas focused awareness programs are at the core of promoting enterprise-level adoption of AI.

The application of Artificial Intelligence to respond to MSME insurance claim management has strategic potential and operational difficulty. Utilizing this research, it was proven that AI models—Random Forest,

Naive Bayes, and ensemble methods—are capable of improving the capacity of insurers to predict claim behavior, predict the settlement period, and identify fraud in the MSME industry. The results also exhibit critical subtleties in the way predictive analytics perform in conformity with the specific operating limitations of small businesses.

## V. CONCLUSION

This research gives an end-to-end data-driven approach to deploying Artificial Intelligence (AI) to processing insurance claims in the MSME space—a segment customarily non-served by conventional insurance infrastructure. Through balancing predictive model methods with actual MSME conduct, the study satisfies two principal requirements: predicting claim risks and outcomes, and optimizing claims processing speed and fraud identification using wiser decision-support. Using various AI algorithms such as Negative Binomial Regression, Random Forest Regressor, Naive Bayes Classifier, and Multiple Linear Regression, the research verifies the fact that predictive analytics can provide insightful answers in even data-scarce situations. The primary conclusions are that average claim amount and turnover attributes play a significant role in influencing settlement duration, and while fraud detection is fairly accurate, there is the possibility of employing it using machine learning classifiers as a level one filter. Interestingly enough, the research also indicates that MSMEs' preparedness to embrace AI tools is based on awareness and not necessarily digital infrastructure, and hence needs education and outreach efforts of a strategic kind.

Ensemble-based decision-support model creation is another example to illustrate the value of hybrid AI systems in enhancing insurance activities for MSMEs. Besides helping in risk stratification and early fraud detection, these tools allow insurers to provide more transparent, faster, and more accurate services to small firms. Although the models utilized were suitable for the dataset, more sophisticated models like deep learning may potentially perform better if larger and subtler datasets were available. Further research needs to analyse longitudinal data, include more varied risk predictors, and report outcomes of real-time AI deployment in order to further generalize and confirm such results. A broader, multi-regional dataset would also facilitate improved model generalizability. The findings of this study affirm the application of AI integration in MSME insurance and pave the way for industry uptake. With the industry continuing to transform, these predictive models can inform insurers on how to deliver scalable, effective, and resilient solutions—one of the drivers of financial resilience and wider digital transformation in the MSME value chain.

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