ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25mar017

Exploring Innovative Approaches in Buyer Differentiation: A Detailed Examination of AI-Powered Methods and RFM-Centric Strategies for Practical Intelligence

[1]Dr. Umesh Akare; [2]Girish Umaratkar; [3]Mukesh P. Giri;
[4]Megha N. Tagade; [5]Ekta N. Chopde

[2]Professor
[1, 2, 3, 4, 5] Department of Artificial Intelligence and Data Science,
Priyadarshini College of Engineering, Nagpur,
Nagpur, 440010, Maharashtra, India.

Publication Date: 2025/03/15

Abstract: In today's competitive retail landscape, understanding and landscape, understanding and predicting customer behaviour is essential for business success. However, traditional data analysis methods can be costly and resource intensive. To overcome these challenges, an innovative system has been introduced that utilizes advanced analytical methods to streamline retail analytics.

This framework is engineered to construct a sturdy model for interpreting and predicting user tendencies. It applies techniques such as multi-criteria classification, visual representation of information, and evaluation of purchasing behavior to segment buyers, investigate their spending trends, and anticipate possible client departure.

Additionally, it utilizes market basket analysis to predict produce purchases and artificial neural networks (ANN) to segment customers and predict churn. Integrating these methods enables businesses to derive meaningful insights into customer groups, buying patterns, and anticipated behaviours, fostering enhanced customer retention and informed strategic decisions.

Keywords*: Retail Analytics, Customer Segmentation, Artificial Neural Networks, RFM Segmentation, Churn Prediction.*

How to Cite: Dr. Umesh Akare; Girish Umaratkar; Mukesh P. Giri; Megha N. Tagade; Ekta N. Chopde (2025) Exploring Innovative Approaches in Buyer Differentiation: A Detailed Examination of AI-Powered Methods and RFM-Centric Strategies for Practical Intelligence. *International Journal of Innovative Science and Research Technology*, 10(3), 103-107. https://doi.org/10.38124/ijisrt/25mar017

I. INTRODUCTION

In today's fast-paced retail industry, data-driven insights are crucial for business success. The paper explores innovative analytical techniques to enhance customer understanding and prediction. By implementing a holistic approach that integrates multi-attribute segmentation, visual representation of data, and customer behaviour evaluation, businesses can derive essential insights into consumer preferences and activities.

In addition, this evaluation explores the integration of linkage discovery and intelligent processing models. Linkage discovery detects connections among goods and uncovers potential supplementary sales possibilities, whereas intelligent processing structures aid in precise client categorization and retention estimation. By implementing these cutting-edge methodologies, companies can refine outreach techniques, strengthen customer dedication, and boost profit enhancement.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25mar017

Ultimately, this paper provides a practical framework for businesses to harness the power of data analytics and make informed decisions that can significantly impact their bottom line.

A. RFM Segmentation: -

RFM examination operates as a reliable framework for interpreting client patterns and advancing outreach methodologies. By analyzing immediacy, repetition rate, and financial contribution, enterprises can detect crucial consumer categories and modify their tactics to accommodate distinct preferences.

Traditional methods like K-Means clustering have been used for RFM segmentation. However, artificial neural networks (ANNs) offer a more robust and adaptable approach. By training an ANN on historical customer data, businesses can accurately predict future behavior and segment customers into meaningful categories.

The RFM segmentation process is carried out through multiple steps. Initially, the data is cleaned by eliminating irrelevant records and addressing any missing values. Following this, customers are assigned scores based on their recency, frequency, and monetary value. These scores are then combined to create a final RFM score, which is used to categorize customers into segments like "Best Customers," "Loyal Customers," and "Lost Customers."

A deep learning architecture is developed using RFM metrics to categorize consumer divisions. The SoftMax algorithm in the model's terminal layer estimates probabilities for each classification. Parameters like exactness, responsiveness, F1-index, and reliability are employed to assess the framework's effectiveness. To counteract overfitting, a prevalent obstacle in data-driven modeling, strategies such as injecting variability into the dataset can be applied.

B. Churn: -

The customer retention analysis unit is developed to recognize individuals prone to discontinuing their network subscriptions. By evaluating consumer records, including elements such as subscription length, recurring fees, and usage patterns, the system applies a deep learning model to forecast attrition with precision. This allows organizations to implement preventive measures and sustain key clientele.

The dataset utilized in this module contains comprehensive information about telecom customers, such as their tenure, subscribed services, billing preferences, and demographic details. The data is meticulously pre-processed to ensure data quality and consistency. Categorical variables are encoded, and numerical features are scaled to facilitate model training.

The neural computation model is arranged in a progressive format, initiating with an input section, advancing through numerous concealed units, and finalizing with an output component. Throughout the training process, a processed dataset is applied, with binary entropy functioning as the loss determinant and the Adam optimizer fine-tuning the parameters. The system's proficiency is assessed using benchmarks such as accuracy, recall, and F1-metric.

- *Data Preparation and Pre-Processing:*

The process begins with loading the raw customer dataset and cleaning it. The customer ID column, which is not relevant to the analysis, is removed. To maintain data integrity, rows containing missing or non-numeric values are excluded.

- *Exploratory Data Analysis (EDA) and Feature Engineering:*

The next phase involves analysing the data to uncover useful insights. Visualization techniques are employed to study the distribution of critical variables, such as tenure and monthly charges, and to detect patterns between churned and retained customers. Categorical variables are converted into numerical forms, with binary categories encoded as 0 and 1.

- *Feature Scaling:*

To prevent features with varying scales from disproportionately affecting the model, numerical attributes are normalized using Min-Max scaling. This method adjusts the values to a predefined range, typically 0 to 1, following a specific mathematical formula.

$$X_{\text{scaled}} = \frac{X - X_{\text{min}}}{X_{\text{max}} - X_{\text{min}}}$$

Fig 1. Min-Max Normalization

- *Data Splitting:*

The dataset is split into two segments: one for model training and the other for assessing its accuracy on unfamiliar data.

- *Model Architecture:*

A forward-propagating deep learning model is developed utilizing TensorFlow/Keras, featuring an initial input unit, multiple hidden processing units, and a concluding output unit optimized for two-class categorization. The optimization phase applies dual-class entropy as the objective function, while the Adam tuner ensures effective adaptation and parameter refinement.

- *Model Training and Evaluation:*

The neural network undergoes a learning phase with the training dataset to detect correlations between input characteristics and the target outcome (churn). Its proficiency is analyzed on the test dataset using evaluation criteria like accuracy, precision, recall, and F1-score to gauge its forecasting effectiveness.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25mar017

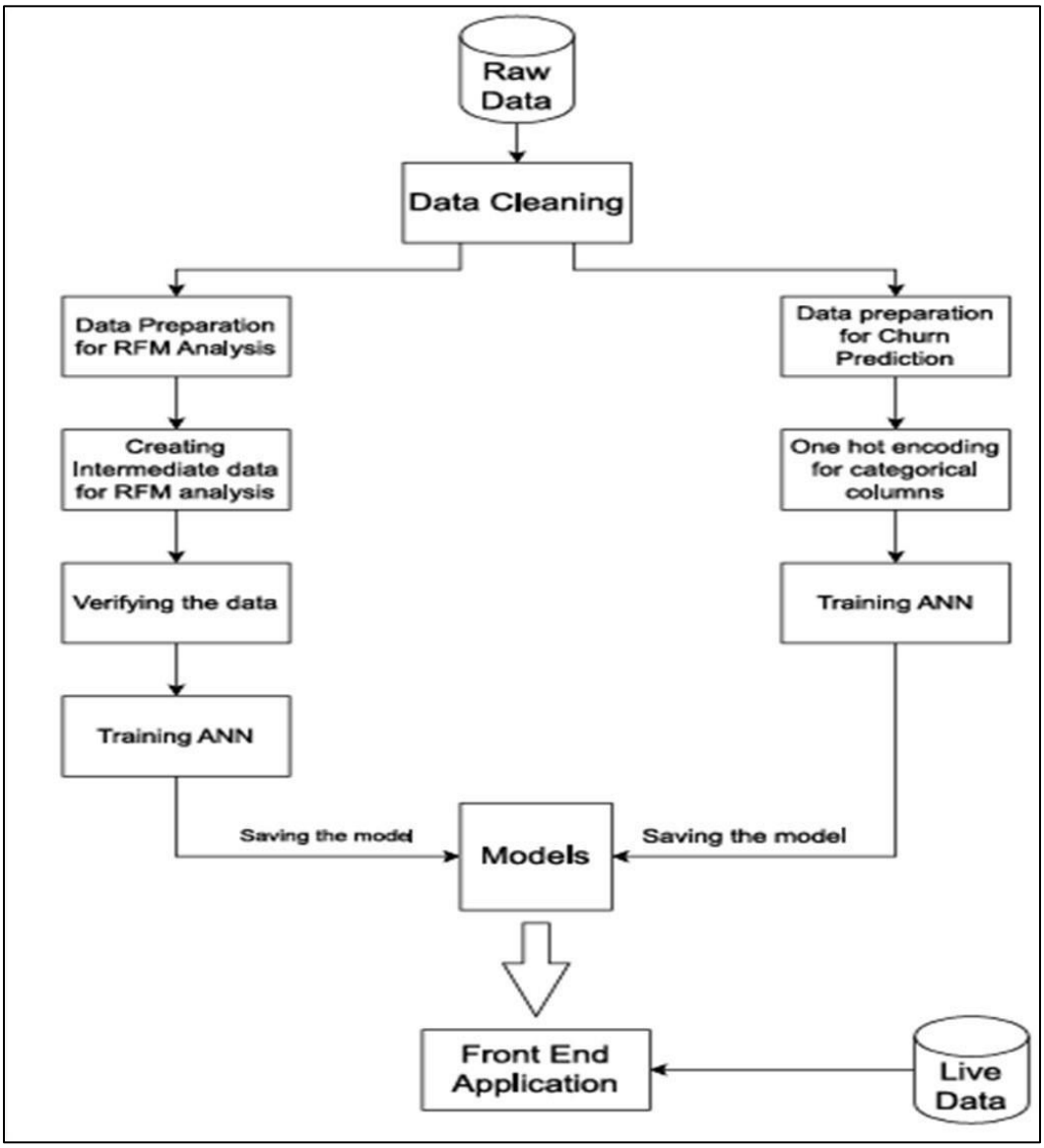

Fig 2. Flow diagram

II. LITERATURE SURWAY

The study “GPHC: A Heuristic clustering method to customer segmentation” by Zhao-Hui Sun, Tian-Yu Zuo (2021) [1], It solved the difficulties for dividing customers when facing real customers using heuristic clustering method for customer segmentation.

In the study titled "Churn Prediction Based on Customer Segmentation Using Machine Learning Techniques" by Chatrasi Amar Lokesh Venkar Siva Sai (2024) [7], decision trees, random forests, and support vector machines are employed to create a robust model for predicting churn. This work highlights the effective application of machine learning in customer segmentation.

The paper titled "Customer Segmentation Using Machine Learning Model: An Application of RFM Analysis," authored by Israa Lewaaelhamd in 2024, explores the application of machine learning techniques in customer segmentation using RFM analysis [3] examines the use of machine learning models combined with RFM analysis for effective customer segmentation., ”Exploring customer segmentation in e-commerce using RFM analysis with clustering techniques” by Chun-Gee Wong, Gee-Kok Tong (2024) [4], “Analysis of Customer segmentation using RFM model and clustering Techniques” by Siti Wulansari, Jerry Heikal (2024) [6] Makes The application of a hybrid approach combining machine learning techniques and RFM analysis for churn prediction. Use of K-means and DBSCAN for clustering. Utilizing machine learning significantly enhances the efficiency of handling large datasets, enabling more straightforward and effective data segmentation.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25mar017

The paper titled "A Review of Data Mining Methods in RFM-Based Customer Segmentation" by E. Ernawati, S.S.K. Baharin, and F. Kasmin (2021) examines various data mining techniques used in RFM-based customer segmentation [2], the authors delve into a variety of data mining strategies applied to the RFM model. By synthesizing these advanced techniques, the study proposes a customer segmentation framework that outperforms traditional heuristic clustering methods.

The article discusses the use of machine learning-driven business intelligence strategies to prevent customer churn in ecommerce, emphasizing proactive retention measures by J. Shobana and Rakesh Kumar (2023) [8] applies machine learning and data mining methods to analyze large-scale customer data, gaining insight into their behaviors. The study leverages support vector machines to enhance the accuracy of churn prediction, making it a key tool in improving customer retention strategies.

Matuszelanski (2022) investigates customer churn in retail e-commerce using spatial analysis and machine learning, focusing on strategies to predict and mitigate churn effectively [9] utilizes the DBSCAN algorithm to differentiate rural and urban areas, analyzing customer neighborhoods through zip codes. For modeling purposes, it incorporates machine learning techniques such as gradient boosting and logistic regression.

The article by John and Ogunleye (2023) examines clustering algorithms applied to customer segmentation in the UK retail sector, emphasizing their role in uncovering actionable consumer insights [12], a customer segmentation model is introduced to support enhanced decision-making in the retail sector. The study employs various clustering methods including K-means, Gaussian mixture models, DBSCAN, and agglomerative clustering.

Rajan and Josephine (2024) [10] explore the application of the K-means clustering algorithm for customer segmentation, focusing on identifying high-value and at-risk customers to enhance targeted marketing strategies. Similarly, Arefin and Parvez (2024) [11] combine RFM segmentation with temporal analysis and supervised learning models like RandomForest, AdaBoost, and XGBoost to predict and understand consumer behavior effectively.

The article “Consumer Segmentation in Retailing: Integrating self- Organizing Maps and K-Means Clustering for Strategic Market Adaptation” by Filipe Simoes, Aydin Teymourifar (2024) [13], it makes use of self-organizing maps (SOMs) and K-means clustering. This research supports the development of tailored marketing strategies, such as targeted promotions for high-income families and dynamic sales.

“Customer segmentation using ANN” by Megha Tagade, Ekta Chopde, Mukesh Giri (2024), This involves the use of Artificial Neural Network for Customer segmentation by using two models RFM prediction and Churn prediction.

III. CONCLUSION

In the realm of retail, understanding customer behavior is paramount to driving business growth and customer satisfaction. This research examined how Artificial Neural Networks (ANN) can enhance customer segmentation by integrating RFM analysis and churn prediction.

By utilizing the RFM model, we effectively categorized customers based on their recency, frequency, and monetary value, enabling a more targeted approach for business strategies. This detailed segmentation allowed us to identify high-value customers, those needing retention strategies, and potential churners.

Furthermore, the integration of churn prediction models, powered by ANN, allowed for proactive identification of customers at risk of attrition. This early warning system empowers businesses to implement targeted retention strategies, minimizing revenue loss and fostering long-term customer relationships. The synergy between RFM analysis and churn prediction, amplified by ANN, offers a robust framework for customer segmentation. By accurately classifying customers into distinct segments, retailers can tailor marketing campaigns, personalize offers, and optimize resource allocation. This ultimately leads to increased customer satisfaction, improved customer retention, and enhanced overall business performance.

REFERENCES

[1]. Zhao-Hui Sun, Tian-Yu Zuo, Di Liang, Xinguo Ming, Zhihua Chen, Siqi Qiu “GPHC: A heuristic clustering method to customer segmentation”,2021
[2]. E ernawati, SSK Baharin, F Kasmin “A review of data mining methods in RFM-based customer segmentation”, Journal of Physics: Conference Series 1869, 2021
[3]. Israa Lewaaelhamd “Customer segmentation using machine learning model: an application of RFM analysis”, Journal of Data Science and Intelligent Systems 2(1), 29-36, 2024
[4]. Chun-Gee Wong, Gee-Kok Tong, Su-Cheng Haw “Exploring customer segmentation in e-commerce using RFM analysis with clustering techniques”, Journal of Telecommunications and the Digital Economy, 2024
[5]. Malay Sarkar, Aishryja Roy Puja, Faiaz Rahat Chowdhury” Optimizing Marketing Strategies with RFM method and K-Means Clustering-Based AI Customer Segmentation Analysis”, Journal of Business and Management Studies, 2024
[6]. Siti Wulansari, Jerry Heikal” Analysis of Customer Segmentation in The Top Three Most Visited E-Commerce Platforms Using RFM Model and Clustering Techniques”, Jornal Scientia, 2024
[7]. Chatrasi Amar Lokesh Venkat Siva Sai, K Sita Kumari, Batchu Anush Gupta “Churn Prediction Based on Customer Segmentation Using Machine Learning

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25mar017

Techniques",2024 International Conference on Automation Computation, 2024
[8]. J Shobana, Ch Gangadhar, Rakesh Kumar Arora, PN Rejith, J Bamini, Yugendra devidas Chincholkar" E-commerce customer churn prevention using machine learning-based business intelligence strategy",2023
[9]. Kamil Matuszelanski, Katarzyna Kopczewska "Customer churn in retail e-commerce business: Spatial and machine learning approach" Journal of Theoretical and Applied Electronic Commerce Research ,2022
[10]. Dhivya Rajan, VL Helen Josephine "Data Mining Techniques to Enhance Customer Segmentation and Targeted Marketing Strategies",15th International Conference on Computing Communication and Networking Technologies, 2024
[11]. Sydul Arefin, Rezwanul Parvez, Tanvir Ahmed, Mostofa Ahsan, Fnu Sumaiya, Fariha Jahin, Munjur Hasan "Retail Industry Analytics: Unraveling Consumer Behavior through RFM Segmentation and Machine Learning", IEEE international Conference on Electro Information Technology, 2024
[12]. Jeen Mary John, Olamilekan Shobayo, Bayode Ogunleye "An exploration of clustering algorithms for customer segmentation in the UK retail market",2023
[13]. Filipe Simoes, Aydin Teymourifar "Consumer Segmentation in Retailing: Integrating Self-Organizng Maps and K-Means Clustering for Strategic", 2024