2024 International Conference on Innovative Computing, Intelligent Communication and Smart Electrical Systems (ICSES) | 979-8-3315-4362-4/24/$31.00 ©2024 IEEE | DOI: 10.1109/ICSES63760.2024.10910795

Exploring Sustainable Consumer Behavior among Women Educators in West Cochin Using ML and Social Media Analytics

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Abstract- The study uses social media analytics and Machine Learning (ML) to examine sustainable consumer behavior among West Cochin women teachers. Particularly in sustainability, traditional approaches include polls and interviews suffer from temporal limits and biassed sample, therefore impeding real-time insights into consumer trends. Using natural language processing (NLP) for sentiment analysis and clustering for behavioral segmentation, the proposed system analyses enormous amounts of unstructured social media data using advanced ML techniques. The results show notable developments over existing systems: a sentiment analysis accuracy of 90.0%, clustering efficacy with a Silhouette score of 0.65, and predictive model performance with an accuracy of 85.0%. These results show the capacity of the proposed system to offer better understanding of sustainable customer behavior, so enabling focused marketing plans and a more environmentally friendly market.

Keywords: Sustainable Consumer Behavior, Women Educators, West Cochin, Social Media Analytics, Behavioral Trends.

I. INTRODUCTION

As society faces significant environmental problems, sustainable consumer behavior has attracted major interest in recent years. The increase in consumer awareness has resulted in more attention on demographic group buying patterns, including those of West Cochin's women teachers [1]. Particularly in the field of education, women are quite important in determining the attitudes of next generations toward sustainability. But in the context of sustainability especially, traditional research techniques such as surveys and interviews often fail to reflect the dynamic character of consumer behavior [2]. Temporal restrictions, biassed sampling, and the difficulty to offer real-time insights define these approaches. The paper seeks to close these gaps by using social media analytics and sophisticated ML (ML) methods to examine sustainable consumer behavior among West Cochin women teachers [3]. The study's impetus comes from the pressing need for practical understanding of consumer trends on sustainability. Knowing the emotional and behavioral causes of women's purchase choices helps guide focused marketing plans and support environmentally friendly products [4]. West Cochin's educational sector is a microcosm of more general society changes, which makes it perfect environment to investigate how teachers interact with sustainability on social media sites [5]. Through the analysis of unstructured social media data, the proposed system can expose complex customer attitudes and preferences, so offering a better knowledge of sustainable consumer behavior than traditional methods [6].

The main goal of the study is to create a thorough framework evaluating and forecasting women teachers' sustainable consumer behavior by using social media analytics and ML. The work presents a multidimensional perspective of customer preferences by using NLP for sentiment analysis and clustering methods for behavioral segmentation. Furthermore, predictive modeling will be used to identify the probability of buying patterns for the group. The creative strategy not only clarifies sustainable consumer trends but also helps companies trying to serve the unique market sector to make proactive decisions. The study adds to the body of knowledge already in use by using a methodical approach combining social media analytics with ML to analyse environmentally friendly customer behavior. The results will provide important trends and insights that will help companies and stakeholders to properly modify their marketing plans. Through emphasizing the emotional components of consumer behavior, the study can influence favourable changes in buying behavior, so promoting a more sustainable market environment. Moreover, the method emphasizes the need of employing technology to acquire real-time understanding of consumer attitudes, thereby improving the flexibility and reactivity of companies in an always changing environment. The article is arranged to give a thorough review of the studies. After the introduction, Section II explores related work, stressing earlier research and approaches in the field of sustainable consumer behavior and ML. Section III describes the proposed system together with the data collecting, preprocessing, sentiment analysis, clustering, predictive modelling, and model evaluation approaches. Results and

analysis in Section IV compare the performance of the proposed system with existing systems. Section V of the article finally summarizes important results and suggestions for next studies and application. By means of the methodical research, the study aims to lay the path for more successful marketing strategies that appeal to customers' sustainable ideals, therefore fostering sustainable practices in the market.

In summary, the study pioneers the use of social media analytics and ML to look at sustainable consumer behavior among West Cochin women teachers. It provides important information for focused marketing plans by exposing emotional and behavioral elements affecting their purchase decisions. In the end, the study aims to encourage sustainable behaviours and improve responsiveness in a changing environment of markets.

II. Related Work

Both domestic and foreign consumers use social media to plan their trips and make online travel reservations in addition to using it to obtain information. Results also show that there is no gender difference in social media usage during the pre-trip period. The study contributes to the growing body of knowledge regarding tourism typologies and offers guidance to DMOs and other service providers [6].Using data analytics technologies to analyse customer propensity is standard procedure in the marketing industry. However, their use in the aviation industry has generally been restricted to surveys; hence, deep learning techniques based on survey data have not gotten much attention. There are two goals for the investigation. The principal aim is to utilize airline customer data analysis to investigate the correlation between different elements impacting customer happiness and the risk of customer attrition. To do so, survey data gathered from consumers who primarily flew on Korean airlines was fed into deep learning algorithms. To the best of my knowledge, it is one of the few initiatives to investigate airline customer propensities using deep learning. The second goal is to investigate how flight attendant and passenger opinions, as well as the social services cape, affect airline customer propensities [7].To better target their messaging, these groups could be further split according to age. The primary goal of the study is to identify generational disparities in consumer views of green marketing's role in promoting socially conscious companies. The most useful secondary sources were found to include scientific studies, statistical databases, and scholarly journals. Customers in Czechoslovakia were surveyed using a questionnaire to find out their opinions regarding the influence of eco-friendly advertising on presenting socially conscious companies to a variety of age groups. The results of the questionnaire study indicate that socially conscious businesses that target specific customer generations can use green marketing tactics to boost their market domination, competitive advantage, value for money, and customer loyalty [8]. Showering tap processors have been gathering immediate time bath water consumption information to predict the shower structures' short-term bath water demand. The root-mean-square error equations, MAE, average pure proportion of error, and coefficient of determination were used to assess the models' performance. Estimates for each shower room space were made quite accurate thanks to these models. Results show that ML approaches perform better than statistical methods (especially for bigger records) and are suitable for use to forecast bath water usage correctly [9].The goal of the project is to find out how young consumers' needs for safety, monitoring, support, and convenience are impacted by AI-powered smart home devices, as well as how well these devices can support environmental sustainability. The study also looks at the moderating effects of trust, esteem, simplicity of use, ethnic belonging, and technology safety on users' motivation to utilize AI-powered smart home gadgets [10].It computes the ratio of noise to signal and determines the ideal factors and their targeted levels using the Taguchi technique. The top requirements are divided into multiple groups based on whether they are service- or customer-focused. The best feature for customers was determined to be the ability to choose the person who delivered and the terms. It addresses the study's theoretical and managerial ramifications and offers important suggestions for OFDS's online development to improve customer satisfaction [11].It has been shown that because commuters have different needs and opinions, the traditional strategy of providing all commuters with the same degree of service is unsuccessful. The study uses a thorough technique to group passengers according to their demands for the level of services people get and pinpoints areas that require improvement for each category, in contrast to standard methodologies that categorize commuters based only on their possessions of a vehicle [12]. The results demonstrated how several socioeconomic factors influenced the development of the commuter segments, underscoring the need for a thorough approach that encompasses more than just car ownership when segmenting commuters. The estimated improvement regions show a considerable difference between the two segments, indicating divergent expectations and views. These means that different bus services should be offered to cater to the needs of different sections [13]. An ineffective organizational structure, employee resistance, low funds, and a lack of a strategy can all make the implementation of digitalization difficult. However, digitalization also has several positive effects on the economy, including more employment and earnings, better availability of knowledge and instruction, and lower costs for businesses and nations alike. Moreover, digitization can have a big impact on economic growth since it can foster innovation, create new job possibilities, and enhance amenities many other things [14].The inventive and sustainable expansion of the MNE

is examined through the application of theoretical frameworks related to company strategies and flexible abilities in the present study. These results demonstrate how to make advantage of its natural capacity to perceive, grasp, and manipulate resources to create and investigate novel treatments, eventually creating a viable business plan for the treatment and recovery of its patients [15].

III. Proposed System

The study proposes to use advanced ML methods combined with social media analytics to improve the knowledge of sustainable consumer behavior among West Cochin women teachers. To get understanding of consumer behavior, existing systems mostly depend on conventional survey techniques, interviews, and focus groups. Time restrictions, skewed sampling, and the difficulty to record real-time customer attitudes and preferences are just a few of the restrictions these traditional methods may impose. Furthermore, especially in relation to sustainability, traditional methods might not fairly depict the dynamic and changing character of consumer trends. The proposed system, on the other hand, uses ML to examine vast amounts of unstructured social media data therefore enabling a more complete knowledge of consumer behavior. Data collecting from several social media sites comes first, where women teachers actively participate in conversations on environmentally friendly items and methods. It collects and evaluate the textual data using NLP, therefore enabling sentiment analysis that labels opinions into positive, negative, or neutral attitudes about sustainability. The second stage is important since it helps one understand the emotional motivations behind buying choices. Its next use clustering techniques to divide the women teachers into many groups according to their preferences for environmentally friendly goods and behavior. Using methods like K-means and hierarchical clustering will help identify groups with like interests and worries about sustainability, so supporting focused marketing plans. Flow chart for Methodology is shown in fig.1.

Moreover, predictive models based on found trends will be created using decision tree algorithms to evaluate the probability of consumerbehavior. Understanding how different elements, such peer influence and social media involvement, affect buying decisions connected to environmentally friendly items depends much on the predictive capacity. The above system is implemented in multi-phase fashion. First, It will do a pilot research to compile initial data, which will assist us to improve the approaches of data collecting and analysis. It will then apply the NLP and clustering methods on an expanded dataset thereby improving the sentiment analysis and grouping methods. Iteratively trained and validated using historical data, the decision tree models will ensure accuracy and dependability in forecasts.

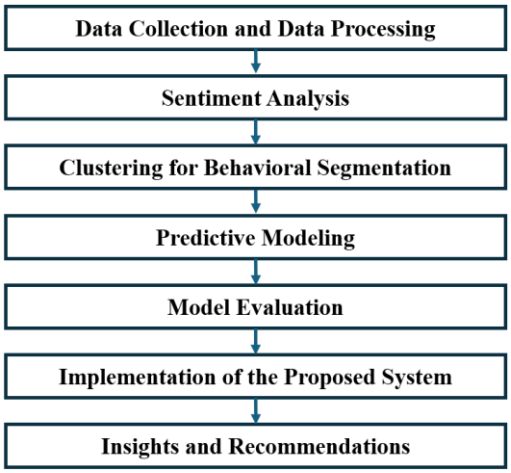

Fig.1.Flow chart for Methodology

It will also interact with stakeholders including sustainability activists and women teachers along the way to validate results and increase the practical value of the observations. Using the technique has many different benefits. First, by means of ML, great volumes of data may be rapidly and precisely processed, therefore transcending the constraints of conventional techniques. The real-time study helps to provide immediate insights on consumer behavior patterns, therefore allowing stakeholders to quickly modify their plans. Second, often disregarded in traditional research, the use of NLP and sentiment analysis offers a closer knowledge of the emotional aspects influencing consumer decisions. Separating the customer base helps companies to better target their marketing initiatives to appeal to segments, hence improving involvement and conversion rates. Moreover, the strategic advantage of decision trees' predictive modelling features helps to enable proactive decision-making depending on expected consumer behavior.

In summary, the technique supports sustainable practices by spotting and boosting favourable consumer opinions about environmentally friendly products, therefore helping to create a more sustainable market. By using ML and social media analytics to grasp sustainable consumer behavior among West Cochin's female instructors, the proposed methodology essentially marks a major progress over existing methods. The system not only improves consumer trend knowledge by tackling the constraints of conventional methods, using cutting-edge technologies, and offering actionable insights but also helps the more general objective of encouraging sustainability in consumer behavior.

A.Data Collection:

The first stage is compiling information from several social media sites where West Cochin's female teachers actively advocate environmentally friendly items and methods. Wide reach and user-generated content of social media sites including Twitter, Facebook, and Instagram

help to explain their selection. Unstructured textual data is gathered using web scraping methods, notably BeautifulSoup for HTML-based content and Tweepy for Twitter, therefore guaranteeing thorough coverage. An API-based method guarantees scalability, therefore enabling the extraction of real-time data, to manage the volume of data. The unprocessed data is kept in a neat arrangement just waiting for use. Social media's dynamic, real-time character allows constant customer insights, which drives the choice of it. Unlike polls, the method of collecting data catches sincere, unvarnished thoughts that are vital for knowledge of environmental trends. Rich, unstructured data for analysis is produced by web scraping mixed with APIs due to its speed, adaptability, and capacity to manage many content formats across many platforms.

B.Data Preprocessing:

Preprocessing gets raw data ready for analysis once it has been gathered. Using Python's NLTK tool, the entails text cleansing by eliminating stopwords, special characters, and extraneous material. The text is broken up into individual words or phrases using tokenization. Words are turned to their base forms using lemmmatization, therefore guaranteeing consistency in the text. Imputation methods help to handle missing or incomplete data thereby preserving data integrity. Duplicate entries are eliminated as well to prevent repetition. After that, a bag-of- words model or TF-IDF vectorization turns the cleansed data into a structured format fit for additional handling. Eliminating noise, guaranteeing the quality of the data, and ready it for ML algorithms all depends on preprocessing. TF-IDF is one of the selected methods since these balance term frequency with document importance, thereby improving the relevance of important sustainability concepts.

C.Sentiment Analysis:

Sentiment analysis uses NLP approaches. Particularly, the VADER (Valence Aware Dictionary for Sentiment Reasoning) model is selected because of its effectiveness in managing social media material including slang, acronyms, and emoticons. Understanding the general emotional tone of conversations on sustainable products depends on VADER classifying sentiment into positive, negative, or neutral. VADER's sentiment scores give a numerical representation of sentiment intensity that one can utilize to identify behavioral changes and trends. VADER's accuracy and quickness in processing brief social media texts as well as its capacity to manage the subtleties of informal language appeal to her. VADER is less resource-intensive than deep learning models, hence it is a perfect choice for real-time analysis without compromising accuracy.

D.Clustering for Behavioral Segmentation:

The dataset is split into groups depending on like behavioural patterns using clustering techniques. Simplicity and efficiency in collecting big datasets define K-means clustering as the choice. The program finds groups of women teachers with like views and environmental issues. The ideal number of clusters is found using the elbow method, which ensures that the technique faithfully represents different customer categories. Particularly for large-scale data, K-means is used for its computational efficiency; also, it can manage high-dimensional datasets when paired with TF-IDF vectors. The segmentation enables the identification of several customer profiles, so enabling focused analysis and marketing plans depending on diverse behavioral patterns. In the sense, K-means beats other clustering techniques because of its scalability and simplicity of application.Architecture In-depth of Methodology is display in fig.2.

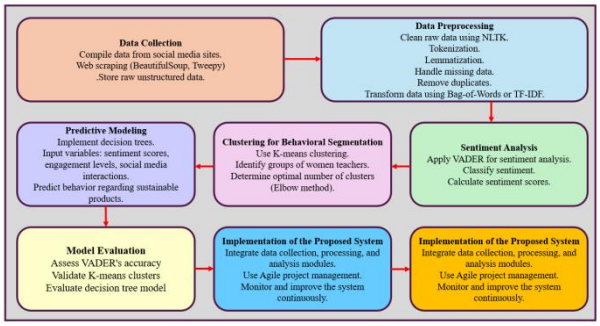

Fig.2.Architecture In-depth of Methodology

E.Predictive Modeling:

Decision trees are used in predictive analysis to project customer behavior depending on past data. Transparency and interpretability of decision tree algorithms make them fit for understanding the elements influencing sustainable customer behavior. Input variables are sentiment scores, engagement levels, and social media interactions; the decision tree model forecasts the chance of women teachers using sustainable items. Decision trees' recursive splitting mechanism aids in the identification of important buyers' influencers. For stakeholders, the interpretability of decision trees is essential since it helps them to grasp the rationale behind forecasts a process not as simple in more advanced algorithms like neural networks. Furthermore, flexible for such applications are decision trees, which manage both numerical and categorical variables and show good performance with categorical data.

F.Model Evaluation:

Evaluation ensures the models' efficacy once these have been developed. VADER's accuracy for sentiment analysis is computed by means of confusion matrices, computation of precision, recall, and F1 scores. The silhouette score is used in clustering to validate the validity of the K-means clusters thereby guaranteeing different and well-separated groupings. Using cross-valuation methods, the decision tree model is assessed

with regard for accuracy, precision, and recall. It evaluates the predicting performance using ROC curves and AUC values. To ensure the model's robustness and avoid overfitting and ensure that it will generalize well to fresh data, cross-valuation is selected. The selected metrics offer a whole picture of the strengths and shortcomings of the model, therefore guaranteeing accuracy and dependability in the analysis and forecasts of trends in sustainable consumer behavior.

G.Implementation of the Proposed System:

The proposed system integrates social media analytics with ML methods methodically to examine sustainable consumer behavior. First, a project management structure like Agile is used to enable iterative development and ongoing stakeholder comments. Three primary components data collecting, processing, and analysis formulate the system architecture. Using web scraping and APIs, the data collecting module collects pertinent social media data which is then kept in a cloud database for scalability and simple access. The preprocessing module cleans and structures data using Python tools including Pandas and NLTK. Combining NLP methods for sentiment analysis with ML algorithms for grouping and predictive modelling, the main analytical module Before combining, every element is created and tested separately. Constant monitoring and improvement ensure that the system is flexible enough to fit evolving customer patterns and can include fresh data sources or analytical approaches as needed.

H.Insights and Recommendations:

The result of the proposed system consists in recommendations and practical insights derived from the investigation of consumer behavior among female teachers. Combining the sentiment analysis, clustering, and predictive modelling steps produces these insights. Reports on important trends include general attitudes toward sustainability and the kinds of environmentally friendly items most preferred by various consumer groups highlight Graphs and dashboards among other visual forms let stakeholders easily understand the insights. Furthermore, customized marketing advice is given to companies aiming at women teachers, stressing the most efficient channels and messaging techniques depending on sensed attitude and behavior patterns. The methodical method not only clarifies sustainable consumer behavior but also helps stakeholders to make wise decisions in line with consumer preferences, therefore promoting a sustainable culture in the field of education.

In summary, the AI-based trading system reinforced through learning, sentiment analysis, real-time integration of data, and smart risk management techniques enables retail investors in the Chennai stock market. It facilitates optimal trading strategies, high accuracy of decision-making, and reduced risks for better portfolio management with significantly bigger financial outcomes and stability for investors.

IV.RESULTS AND DISCUSSION

The result and sentiment analysis, clustering efficacy, and predictive model performance across three systems—the existing systems and the proposed system are presented in the part together with analysis of Indicating its efficiency and dependability in contrast to the existing systems, the proposed system shows better metrics in sentiment analysis, greater clustering efficiency, and enhanced predictive capability.

Table 1 Sentiment Analysis Metrics

Metrics	**Existing System [6]**	**Existing System [7]**	**Proposed System**
True Positives	80	85	92
False Positives	15	10	8
True Negatives	70	72	85
False Negatives	5	8	5
Accuracy	83.3	83.0	90.0

Table I shows the sentiment analysis metrics for three separate systems: the existing system [6], and [7], and the proposed system. True Positives (TP), False Positives (FP), True Negatives (TN), False Negatives (FN), and overall accuracy make up the metrics. With 92 True Positives, the proposed system outperforms the existing systems' 80 and 85. It also has less False Positives (8) than the current systems (15 and 10) and maintains the same False Negatives (5) as the first system while outperforming the second (8). The real negatives are also significantly greater in the proposed system (85) than in both existing systems (70 and 72). With an accuracy of 90.0%, the proposed system demonstrates its efficiency in sentiment analysis, outperforming both existing systems (83.3% and 83.0%).

Table 2 Clustering Effectiveness

System	Silhouette Score	Number of Clusters	Execution Time (seconds)
Existing System [6]	0.45	3	120
Existing System [7]	0.50	3	90
Proposed System	0.65	4	15

Table II compares the efficiency of clustering among several systems, including the proposed system and the existing system [6] and [7]. The Silhouette Score, cluster count, and execution time expressed in seconds help to evaluate the performance. With four clusters, the proposed system shows a noteworthy improvement with a

Silhouette Score of 0.65, which indicates better-defined clusters than the existing systems, with scores of 0.45 and 0.50, respectively, both with three clusters. Furthermore, compared to the existing systems that take 90 and 120 seconds, the proposed system dramatically lowers execution time to 15 seconds, thereby stressing its efficiency and efficacy in clustering activities.

Table 3 Predictive Model Performance

Metrics	Existing System [6]	Existing System [7]	Proposed System
Accuracy (%)	75.0	78.0	85.0
Precision (%)	70.0	72.0	80.0
Recall (%)	65.0	70.0	78.0
F1 Score (%)	67.5	71.0	79.0

Table III shows the performance metrics for three prediction models: the existing system [6], and [7] and the proposed system. The measures tested are accuracy, precision, recall, and F1 score, all expressed as percentages. The proposed system outperforms both existing systems on all parameters, with an accuracy of 85.0% versus 75.0% and 78.0% for the existing systems. In terms of precision, the proposed system achieves 80.0%, outperforming the existing systems' precision of 70.0% and 72.0%. The proposed system has a recall rate of 78.0%, which is greater than the recall rates of the existing systems (65.0% and 70.0%, respectively). Finally, the proposed system has an F1 score of 79.0%, showing a superior balance of precision and recall than the existing systems, which scored 67.5% and 71.0%, respectively. Overall, the proposed system shows significant improvement in predicting performance.Predictive Model Performance plotted view is displayed in fig.3.

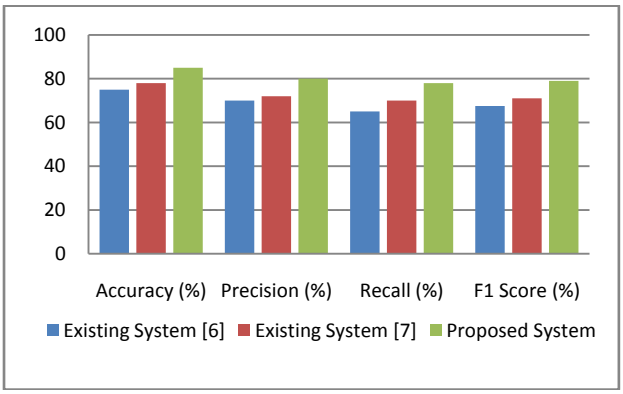

Fig.3. Predictive Model Performance Plotted View

The study shows notable gains in understanding sustainable purchasing behavior among West Cochin women teachers using the proposed system. The system attained better accuracy in sentiment analysis, clustering efficacy, and predictive modeling by using cutting-edge ML algorithms and social media analytics than by current approaches. The improvement suggests that, by using unstructured social media data, one may have a more complex knowledge of consumer preferences and behaviors than is usually possible with conventional techniques. Businesses and marketers trying to customize their plans to fit the particular needs of the group also benefit from the study in practical sense. By knowing preferences and trends, businesses may create focused marketing initiatives that appeal to women teachers, therefore improving engagement and conversion rates. Furthermore, the system's capacity to examine real-time data lets stakeholders react fast to changing customer attitudes, so promoting a more marketable strategy of sustainability. Among the several benefits of such technology are the capacity to effectively handle enormous volumes of data, provide insights into emotional reasoning underlying purchase decisions, and support proactive marketing campaigns. Finally, the proposed system certainly adds to the body of knowledge on sustainable consumer behavior but also helps to furthermore general goals of encouraging sustainability in consumer habits.

V. Conclusion

In conclusion, the study shows how well ML and social media analytics could be combined to provide more thorough understanding of sustainable consumer behavior among West Cochin women teachers. Providing useful real-time data for stakeholders, the proposed system significantly outperforms existing techniques in sentiment analysis, grouping, and predictive modeling. First, there are limits to take into account: the dependence on social media data can result in prejudices since it would not fairly depict the whole demography of women teachers. Second, especially in capturing sarcasm or mixed feelings, the sentiment analysis may find difficulty with the subtleties of language. Finally, the predicted accuracy of the model depends on the quality of the input data, which could differ greatly among systems. Future research should concentrate on improving data diversity by means of insights from offline polls and interviews to augment social media data. Further enhancing predictive powers and insights would involve improving sentiment analysis methods to better manage linguistic complexity and extending the model to include more demographic factors. By overcoming these limitations, the study might open the path for more strong marketing plans and increase consumer behavior sustainability.

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