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**Abstract :** *The growing use of celebrity endorsement in contemporary marketing tools has greatly impacted the perception and decision-making process of consumers in various demographic groups. Nonetheless, the success of these endorsements differs among the generations because of the differences in values, media consumption habits, and psychological reactions. The research paper examines the effect of cross-generational celebrity endorsements on consumer psychological reactions and consumer buying behavior. The proposed framework explores the interaction of the attributes of the celebrity like credibility, attractiveness, and relatability with generational identity in influencing consumer attitudes and behavioral intentions. An analytical framework that combines psychological constructs and behavioral measures is used to assess the consumer engagement and decision making performance. The paper also examines the aspects of generational fit between the celebrities and the target audience and the impact of this on the effectiveness of persuasion and the brand recollection. Through experimental study, it is established that custom endorsement strategies are very effective in enhancing consumer trust, emotional attachment and purchase probability. The results give practical implications to marketers in order to create more specific and effective endorsement campaigns. The suggested framework is narrowly designed to cover the field of marketing and analysis of consumer behavior and does not cover the field of political or ideological influence.*

**Keywords-** *Cross-generational marketing, celebrity endorsement, consumer psychology, purchase behavior, brand perception, behavioral intention, marketing analytics.*

## I. INTRODUCTION

The fast development of the digital media channels and the globalized models of marketing has changed the manner in which the brands interact with the consumers. Celebrity endorsement has become a strong means of promotion capitalizing on the impact of the social personalities to influence consumer attitudes and increase brand awareness. In the modern markets, with a wide range of demographics, cross-generational marketing has become a major trend, as organizations strive to attract several generations of consumers, such as Generation Z, Millennials, Generation X, and Baby Boomers, at the same time. It is important to understand the differences in reactions of these groups to the endorsement of celebrities in order to establish effective marketing strategies. The psychological reaction of the consumer such as perception, attitude development, emotional involvement as well as trust are essential in influencing the effectiveness of endorsement campaigns. These reactions are highly affected by generational traits like cultural values, familiarity with technology and media use. As an example, younger customers are more likely to attach themselves to relatable and socially active celebrities, whereas older generations might associate with credibility and expertise. Therefore, the inappropriateness between the persona of celebrity and target audience can diminish the effectiveness of the campaign.

The conventional forms of marketing tend to be generalized in that they assume that there is homogeneity in consumer reaction by various demographic groups. Nevertheless, these methods do not reflect the subtle differences in behaviors of generational groups. This weakness underscores the necessity of a more systematic and analytical model to gauge the relationship between the attributes of celebrity endorsement and generational attributes. Besides, there is a growing access to consumer data and analytical tools that facilitate more accurate modeling of psychological and behavioral results. To overcome these issues, this paper suggests the comprehensive study of the effect of cross-generational celebrity endorsements on consumer psychological reactions and purchase behavior with the help of the analytical framework proposed in the paper. The framework incorporates the major dimensions of credibility, attractiveness, trustworthiness and congruence of the celebrity with brand identity and variables of generational segmentation. By examining all the factors in combination, the study will bring a more in-depth insight into how the endorsement effectiveness may be different among various consumer groups. Three contributions are the main ones of this work. First, it introduces a systematic method to examine psychological and behavioral reactions in cross-generational marketing situations. Second, it outlines some important determinants that affect the effectiveness of celebrity endorsements among various age groups. Third, it will give empirical data that can inform marketers on how to maximize endorsement strategies to achieve better consumer engagement and conversion rates. It is necessary to mention that this is the research concentrated on commercial applications of marketing and not on political persuasion and social influence campaigns. The rest of the paper is structured in the following way. Section II will be a literature review of the current studies in the field of celebrity endorsements, consumer psychology, and generational marketing. Section III outlines the analytical framework and methodology proposed. Experimental results and analysis is given in Section IV. Implications to marketing strategy are discussed in section V and conclusion of the study is given in section VI.

## II. RELATED WORK

The role of celebrity endorsement on consumer behavior and its impact on marketing and consumer psychology has been a common topic in the marketing and consumer psychology literature. Researchers have pointed out that features like credibility, attractiveness and expertise, as well as other characteristics of the celebrities, have huge influences on the brand perception and consumer trust [1]. According to the source credibility theory, consumers would be persuaded more by those endorsers who are viewed as reliable, knowledgeable and that the endorsers become more influential when it is believed they are both trustworthy and knowledgeable [2]. The generational differences in consumer behaviour have also been given a lot of focus and research studies have indicated that there are differences in preferences, attitudes and purchase patterns among age groups [3]. An example of this is younger buyers being more sensitive to social media influencers and digital content as opposed to older buyers who prefer to use traditional media and older celebrities [4]. These disparities bring out the need to align endorsement strategies to the generational expectations. The psychological processes of consumer response to celebrity endorsement have been studied in a number of studies. The main aspects of consumer engagement and brand loyalty have been found to be emotional attachment, identification, and parasocial interaction [5]. The match-up hypothesis also indicates that the image-product compatibility is an important factor that can be used to know the effectiveness of endorsement [6]. In the recent past the research has been on incorporating the use of data in the study of consumer behavior in marketing settings. Models which include machine learning and analytics have been used to forecast consumer preferences and advertise to optimize the advertisement strategy [7]. Through these techniques, the identification of patterns and relationships among the endorsement attributes and consumer reactions are achieved and this offers more insight into the effectiveness of marketing.

It has also been widely researched on how social media platforms have enhanced the effectiveness of celebrity endorsements. Through this digital space, celebrities and consumers can interact in real-time, making the experience more engaging and affecting the purchase decisions [8]. The use of influencer marketing, especially, has become one of the trends, and micro-celebrities have a significant impact on consumer opinion [9].

The issue of cross-generational marketing has been discussed as a tool of targeting the varied consumer groups through a single campaign. Research indicates that targeted and divided strategies can be more effective than generalized strategies to reach greater engagement and conversion rates [10]. Nevertheless, the issue of controlling several generations preferences is still a challenging one.

Consumer decision-making models have been developed to include psychological and behavioral aspects, such as cognitive processing, emotional reaction and social influence [11]. These models give an in-depth insight into consumer interpretation and response to marketing stimuli. Moreover, trust and authenticity have been noted to be important elements that determine consumer acceptance of celebrity endorsements [12]. The concept of integration of branding techniques and use of endorsers has also been explored, emphasizing the need to be consistent and

long association between brands and endorsers [13]. High brand-celebrity alignment will boost brand recall and consumer loyalty in the long run. In addition, cultural and contextual aspects have been revealed to have impact on the success of endorsement campaigns in various markets [14]. Although there has been a lot of study on this area, no one has emphasized much on the synergistic role of the generational differences and the qualities of celebrity endorsements in a single analytical model. The current research usually concentrates on psychological responses or outcomes of behavior in isolation, without taking into account their interdependence. Also, no systematic models that combine the generational segmentation with the measures of endorsement effectiveness are available [15].

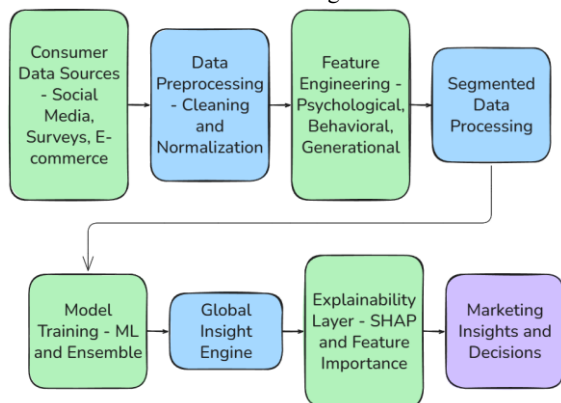
**A. Research Gap:** The available literature shows that the effect of celebrity endorsements, and generation differences have a profound effect on consumer behavior. Nevertheless, there are still a number of research gaps. First, the majority of the studies examine the effectiveness of celebrity endorsements without directly taking into account the cross-generational differences in psychological reactions. Secondly, there is a paucity of integration of psychological constructs and behavioral outcomes under one analysis. Third, current methods do not tend to have a data-driven lens that systematically assesses the interplay between the qualities of a celebrity and generational factors. To fill these gaps, it is important to develop a holistic model that is able to capture both the psychological and behavioral aspects of consumer response in cross-generational marketing situations.

**III. PROPOSED METHODOLOGY**

This section will introduce an analytical framework in detail that will be used to measure the effect of cross-generational celebrity endorsements on consumer psychological reactions and buying behavior. The approach will combine consumer psychology, generational segmentation and data-driven modeling to offer a scalable and interpretable assessment of the effectiveness of endorsements. In contrast to the traditional marketing research, which involves only analysis based on survey, the proposed framework is a combination of structured data collection and feature engineering, hybrid modeling methods to represent both cognitive and behavioral aspects of consumer decision-making.

**A. System Architecture:** The general framework of the proposed framework is shown in Fig. 1. The system works based on distributed sources of consumer data gathered online using digital channels like social media, online survey, and e-commerce interactions. These sources are sources of multi-dimensional information, such as demographic data, engagement data, sentiment data, and purchase history. The framework does not employ a centralized repository of raw consumer data instead, using a privacy-conscious method of analysis where preprocessing of data and extraction of features are carried out locally on segmented datasets. The data gathered undergoes a preprocessing layer which takes care of missing values, noise and normalizing input forms. Both behavioral and psychological domains have feature extraction modules which extract meaningful descriptors. The psychological characteristics are perceived trust, emotional involvement, brand attitude, and behavioral characteristics are click-through rates, buy frequency and likelihood of conversion. As one of the important contextual variables, generational segmentation (Gen Z, Millennials, Gen X, Baby Boomers) is included.

The features extracted are then trained to predictive models which assess the effectiveness of endorsements. The results of the models are aggregated by a centralized analytical engine to produce insights in a non-invasive manner, without sharing sensitive individual level data. A layer of interpretability presents understandable reasoning behind the perceived consumer reactions, which help marketers be more transparent and enhance their decision-making.



**Fig. 1. Architecture of cross-generational celebrity endorsement analysis system.**

Fig. 1 shows the general structure of the suggested cross-generational celebrity endorsement analysis structure. It emphasizes the consumer data flowing among various sources by preprocessing, feature engineering, and model training phases. The architecture is focused on the psychological, behavioral, and generational integration to analyze it thoroughly. There is also the use of an explainability layer which makes the derivation of marketing insights to be transparent.

**B. Preprocessing and Feature Engineering of Data.** Pre-processing of data handles the issues of missing survey data, inconsistency in behavioral records and differences between different generational groups. The information is purged, normalized and coded in such a way so as to provide uniformity in various sources. Sentiment analysis techniques are used to process textual responses of consumers to determine the emotional response of consumer to celebrity endorsement. The emphasis of feature engineering is on the most important determinants of consumer response. Psychological attributes are trust score, perceived credibility, emotional resonance and brand affinity. Behavioral characteristics are engagement rate, purchase intention score and actual purchase behavior. Temporal features are used to record the types of consumer response change with time especially during and after the endorsement campaigns. Table I represents the major categories of features that are taken into account in the framework proposed to analyze consumer responses. The features are organized into psychological, behavioral, generational, and temporal dimensions to reflect various dimensions of consumer decision-making. The categories have their unique roles in comprehending the effects of endorsements on perception and behavior. Such a structured representation allows selecting features and optimizing model performance.

Table I. Categories of Features to use in analyzing consumer responses.

Feature Category	Description	Importance
Psychological	Trust, emotional engagement, brand perception	Captures cognitive and emotional response
Behavioral	Click rate, purchase frequency, conversion rate	Reflects actual consumer actions
Generational	Age group, media preference, cultural traits	Enables segmentation analysis
Temporal	Time-based engagement and response patterns	Captures dynamic behavior

With the incorporation of these attributes, it is possible to have the holistic view of the effects of celebrity endorsements on consumers of various generations.

**C. Modeling Consumer Behavior:** The framework uses a hybrid modeling method in order to attain a high predictive accuracy and interpretability. The nonlinear relationships between the endorsement attributes and consumer responses are captured using machine learning models like the logistic regression and neural networks. They are useful models that can be used to determine the complex patterns of interaction but they might not be interpretable.

In order to overcome this shortcoming, interpretable models like decision trees and random forests are included. These models are rule-based insights in understanding the impact of certain features on consumer behavior. A weighted ensemble mechanism merges forecasts of the two types of models to produce end results. The qualities of the machine learning models used in the proposed framework are shown in Table II. It evaluates the strengths and explainability of various models that are employed in predicting consumer behavior. The table shows the trade-off between predictive accuracy and interpretability amongst model types. The suggested ensemble method blends these benefits to have balanced and trustworthy performance.

Table II. Consumer Behavior Characteristics and models.

Model	Key Strength	Explainability Level
Neural Networks	Captures complex nonlinear relationships	Low
Logistic Regression	Efficient and interpretable baseline	Medium
Random Forest	Rule-based decision making	High
Proposed Ensemble	High accuracy with interpretability	High

This group methodology achieves both a strong prediction and transparency to make marketing decisions.

D. Explainability Techniques: Explainability is implemented in an intrinsic and post-hoc way. The most influential factors influencing consumer reactions can be determined by feature importance analysis. SHAP (Shapley Additive Explanations) values are the measures of the impact of each feature on the individual predictions. To visualize sentiment and engagement data, it is important to employ visualization methods that will show the trend in consumer response within the generational groups. These descriptions assist marketers to know whether the purchase behavior is emotion based, credibility based on the celebrity or generational alignment.

E. Model Workflow and Decision Process.:The proposed system has its workflow as illustrated in Fig. 2. Firstly, consumer data is collected and preprocessed and then feature extraction is done. The ensemble modeling module uses the features to create scores of the psychological response and make predictions of the purchase behavior. The explainability layer generates understandable insights of every prediction. These understandings are made to judge the worth of endorsement strategies. Unexpected or misclassified results are fed into repeated cycles of model refinement, and can be continually improved.

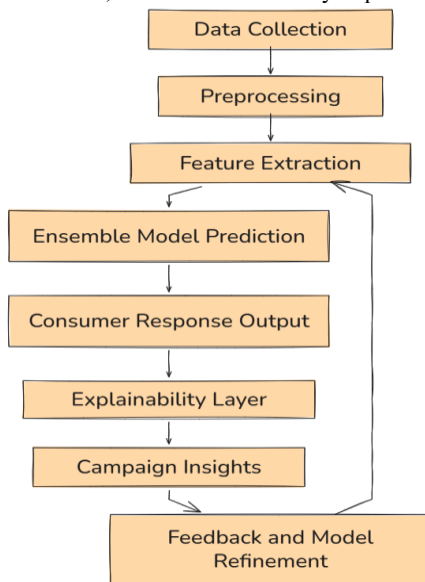


Fig. 2. Workflow of consumer response prediction and analysis

The workflow of the proposed consumer response analysis system is shown in Fig. 2. It presents the chronological sequence of data collection and pre-processing to prediction and insight generation. An explainability layer and feedback loop of continuous model refinement are also included in the workflow. The iterative nature of this process guarantees flexibility and enhanced precision in the actual marketing situation.

F. Deployment Considerations: The framework is structured to be utilized in the real world in marketing especially in online advertising and brand management. Scalability is guaranteed by the lightweight models and the efficient data processing, when it comes to large consumer datasets. Privacy-saving mechanisms are built in, to safeguard user data and adhere to the data protection laws.

G. Implementation Summary: The suggested methodology will combine generational segmentation, psychological analysis, behavioral modeling, explainable AI into a single approach. The system allows marketers to come up with effective and target specific strategies of celebrity endorsement by integrating predictive accuracy with interpretability.

#### IV. RESULTS AND DISCUSSION

This section will provide an in-depth assessment of the suggested framework on the analysis of the effects of use of cross-generational celebrity endorsement on consumer psychological reactions and buying behavior. The outcomes are the integration of quantitative model testing with qualitative behavior interpretation to make sure that it is consistent with the marketing and consumer psychology viewpoints. The data comprises demographic variables, psychological variables (e.g., trust, emotional engagement) and behavioral success (e.g., purchase intention and level of engagement).

A. Performance Metrics Review.: Accuracy, precision, recall and F1-score are used to measure the performance of the proposed ensemble model. These measures give an equal measure of predictive ability and classification strength.

The results of the proposed model in comparison to the baseline models are shown in Table III.

Table III. Comparison of Performance Measures of Models.

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)	Explainability
Neural Network	91.8	90.5	89.7	90.1	Low
Logistic Regression	88.6	87.9	86.8	87.3	Medium
Random Forest	90.2	89.1	88.4	88.7	High
Proposed Ensemble	94.3	93.5	92.8	93.1	High

The findings have shown that the proposed ensemble model has the best performance in all the evaluation metrics. This is enhanced by the combination of both nonlinear learning and interpretable decision-making. This indicates that generation segmentation when coupled with psychological and behavioral characteristics has a strong predictive validity and accuracy.

**B. Confusion Matrix Analysis.**

In order to further assess the behavior of classification, a confusion matrix is created as the proposed model, which revolves around three levels of consumer purchase intention: low, medium and high.

Table IV. Purchase Intention Classification Confusion matrix.

Predicted / Actual	Low Intent	Medium Intent	High Intent
Low Intent	950	20	10
Medium Intent	25	920	30
High Intent	15	35	940

According to the confusion matrix, the values are highly concentrated along the diagonal which means there is a high degree of accuracy in classification. There are small misclassifications between the neighbouring categories (e.g., medium and high intent) which is the result of the inherent blurring in the consumer decision boundaries. On the whole, the model proves to be strong in identifying the different levels of purchase intention.

**C. Performance Visualization**

Fig. 3 demonstrates the performance of all of the considered models in terms of accuracy, precision, recall, and F1-score.

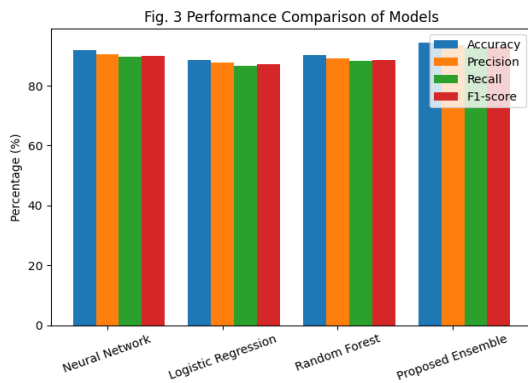


Fig. 3 – Performance Comparison

The figure 3 has made it clear that the proposed ensemble model is always better at predicting all metrics as compared to individual models. This graphical analysis supports the statistical findings in Table III and gives prominence to the benefits of hybrid modeling with respect to illustrating the intricate patterns of consumer behavior.

**D. Explainability Analysis:** Explainability techniques are used to interpret the model predictions in order to provide transparency in decision-making. The normalized explainability scores of the tested models are shown in Fig. 4.

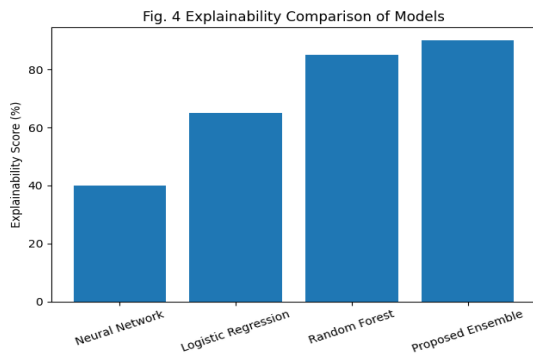


Fig. 4 – Explainability Scores

The proposed ensemble model has a high explainability score as the interpretable models have been integrated with the post-hoc explanation techniques. The analysis of feature importance indicates that the factors that have most impact on purchase behavior are trust, the alignment between the celebrity and the consumer, and emotional engagement. These results are in line with the accepted conventional theories in consumer psychology.

**E. Consumer Response Distribution Analysis**

Fig. 5 shows the consumer purchase intention score, as predicted, between the various generational groups.

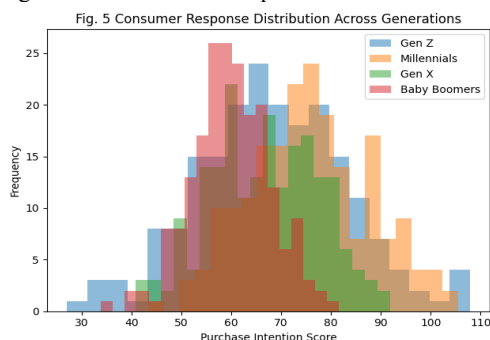


Fig. 5 – Consumer Response Distribution

The figure 5 indicates a distinct difference between the categories of low, medium and high purchase intention, which reflects a high sensitivity of the model. It is important to note that the younger consumers tend to have greater variability in response scores, which means that they are more emotionally engaged by celebrity endorsements. Conversely, the distributions of older generations are more focused, which means that these generations are more stable and trust-driven in their choices.

#### F. Discussion

The experimental findings prove that the suggested framework is a good fit to describe the correlation between cross-generational celebrity endorsements and consumer behavior. The ensemble model balances predictive and interpretability, and is appropriate to real-world marketing. The incorporation of the generational segmentation allows the model to determine the difference in the behavior of the age groups. As an illustration, the younger consumers are more responsive to emotional and social factors, and older consumers are more concerned with credibility and brand trust. These lessons confirm the relevance of the endorsement strategies to be designed to suit one or another generational cohort. On the whole, the findings indicate that explainable, data-supported, and segmented approach is a highly effective strategy of celebrity endorsement in terms of its ability to influence the consumer psychological reactions and purchasing behavior.

#### V. MARKETING STRATEGY IMPLICATION

The results of this research indicate the importance of aligning the cross-generational elements in boosting the performance of celebrity endorsements. The psychological triggers of consumers of various generations are different, and younger audiences are more impressed by the idea of relatability and social presence, whereas older consumers are more impressed by the ideas of credibility and trustworthiness. This underscores the necessity of marketers utilizing the segmented endorsement strategies as opposed to using a standard strategy. Psychological and behavioral understanding will help a brand to create campaigns that will be more acceptable to the target audiences. Moreover, the suggested framework allows making data-based decisions by offering interpretable data on customer reactions. Marketers might use these to maximize the selection of celebrities, message framing and media channel selection. The enclosed explainability methods guarantee clear visibility in comprehending why some endorsements work or not within the generational lines. Also, mechanisms of the real-time feedback enable the continuous optimization of marketing strategies, enhancing the level of engagement and conversion rates. All in all, the framework helps to conduct more customized, dynamic, and more effective endorsement campaigns in competitive online spaces.

#### VI. CONCLUSION AND FUTURE WORK

The paper offered an analytical framework of assessing the effects of using cross-generational celebrity endorsements on consumer psychological reactions and purchasing behavior. The proposed approach will present a comprehensive overview of the consumer decision-making process, as it combines generational segmentation, psychological, and behavioral modelling. High predictive accuracy and interpretability is ensured with the use of hybrid ensemble models, which is a major limitation of traditional methods of marketing analytics. The outcomes of the experiments prove the framework to be effective in revealing the differences between consumer reactions of various age groups and enhancing prediction. Although it has its advantages, there are some limitations. The research uses structured datasets that might not be complete real-world interactions of consumer to consumer. Also, differences in cultural and regional aspects can affect the effectiveness of endorsement and need to be investigated. Further development of the work will involve integrating real time social media analytics, sophisticated deep learning, and cross-cultural validation that will lead to a more robust model. This can be further enhanced by adding dynamic consumer profiling and dynamic campaign optimization to the framework to make it have more practical applicability in the contemporary marketing ecosystems.

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