

I. INTRODUCTION

The rapid growth of the beauty product industry has complicated consumer decision-making, with reviews playing a crucial role [1]. In the digital age, online reviews and social media significantly influence consumer choices, where positive reviews can enhance a product's popularity, and negative reviews can harm a brand's reputation. Analyzing these reviews is essential for businesses to stay competitive [2].

Sentiment analysis, an NLP technique that identifies opinions and emotions in text, is vital for understanding consumer preferences and trends [3]. It is particularly important in digital marketing for the beauty industry, helping companies tailor strategies to meet consumer needs, improve customer satisfaction, and identify product improvement areas. Sentiment analysis helps companies identify key aspects of their products, such as price, packaging, quality, and aroma, and understand consumer perceptions.

Despite advancements in sentiment analysis for the Indonesian language, challenges remain in analyzing mixed-language reviews and optimizing model performance [2]. Mixed-language reviews, where consumers use both Indonesian and English, are particularly challenging due to the complexity of processing multiple languages simultaneously.

Research Problem: This study aims to accurately analyze mixed-language beauty product reviews in Indonesian, which are challenging for traditional models due to language complexity and context. The objectives are to enhance computational efficiency and improve accuracy in sentiment classification, providing valuable insights for digital marketing [2].

Previous research shows progress in this area: Computer et al. achieved 92.6% accuracy using IndoBERT and LSTM for skincare product reviews [4], Maharani et al. achieved 77.78% accuracy with Naive Bayes for GoRide services on Twitter [5], Sholihat et al. obtained 81.07% accuracy with Naive Bayes [6], and Isa et al. achieved 94.66% precision, recall, and F1-score with fine-tuned models on turnbackhoax.id data [7]. Fimoza et al. found that using BERT for sentiment analysis on YouTube movie reviews in Bahasa Indonesia achieved an average accuracy of 66.7% [8].

This study proposes using IndoBERT combined with Naive Bayes for sentiment analysis of beauty product reviews. IndoBERT's understanding of the Indonesian language and Naive Bayes' computational efficiency aim to enhance performance metrics such as accuracy and F1-score [4]. In summary, this study seeks to bridge gaps in existing research by integrating IndoBERT and Naive Bayes for sentiment analysis of beauty product reviews, improving accuracy and computational efficiency, and providing valuable insights for digital marketing [3].