CHAPTER 1
INTRODUCTION

The widespread use of beauty products has led to an increasing number of user reviews being shared online every day. Analyzing these reviews automatically requires sentiment analysis to understand the opinions expressed. Therefore, this study conducts sentiment analysis based on aspects in Indonesian language beauty product reviews using a hybrid CNN-LSTM model with IndoBERT or trainable embedding layer.

1.1 Rationale

The cosmetics industry is experiencing rapid growth, as reported by the Ministry of Industry, with an increase of 6.35% in 2018 and reaching 7.36% in the first quarter of 2019, and a projected growth of between 7% and 9% throughout the year [1]. This growth is driven by the increasing public interest in self-care and beauty products, such as facial cleansers, sunscreens, and moisturizers, which are increasingly popular in the market [2]. In addition, the shift in the trend of purchasing beauty products online has made consumers increasingly dependent on user reviews to assess the quality and suitability of products before purchasing [4]. Platforms such as the Female Daily Network have become important sources of information that provide reviews, blogs, and forums where users share their experiences with various beauty products [3]. These reviews are highly valuable because they provide insight into the quality and effectiveness of products based on consumer needs. Given the importance of these reviews, Sentiment Analysis has emerged as a crucial tool for understanding consumer opinions by classifying sentiments into positive, neutral, or negative categories [5]. However, a more granular approach is often needed, leading to the use of Aspect-Based Sentiment Analysis (ABSA). ABSA not only classifies the overall sentiment but also extracts specific aspects (e.g., price, packaging, texture, aroma) and determines the sentiment associated with each aspect [5].

Various traditional methods have been used in ABSA on beauty product reviews, including Neighbor Weighted KNN (NWKNN) [40], Random Forest with TF-IDF [41], and Support Vector Machine (SVM) with n-gram words [42].

Although these approaches produce fairly good performance, statistical-based methods still have limitations in capturing semantic relationships between words. Another study by Vazan et, al applied the ensemble method with stacked CNN with different dimension embedding input and Persian cinema review sentences, the results showed that the accuracy of the proposed model got a better value than a single CNN, which was 87.65% [8]. In addition, Imron et al. applied the CNN method for aspect extraction on product reviews from the Bukalapak marketplace, because of its effectiveness in extracting local features from text data [5].

Although CNN was successful in feature extraction, the results were less than optimal in capturing the sequence of words that affect sentiment, which means that CNN alone is not accurate enough for sentiment classification at the aspect level, because CNN has limitations in capturing temporal dependencies and long-term contexts in text. To overcome these limitations, it is necessary to combine CNN with a method that can capture long-term dependencies in text, such as Long Short-Term Memory (LSTM) [9]. LSTM is designed to understand the order and context of sequential data, so it is effective in capturing relationships between words spread across sentences. By combining CNN and LSTM, the model can leverage the strengths of both, research by Ankita, et al. [10] on tweets related to #blacklivesmatter. The classification methods used are CNN and LSTM to detect public sentiment and emotions based on tweets from two US provinces. This study proposes a hybrid method, namely CNN-LSTM which is validated through Random Forest, CNN, LSTM and Bi-LSTM, BERT base, BERT large. The results of the study show that the Random Forest method obtains an accuracy of 77.35%, the CNN method obtains an accuracy of 79.46%, LSTM obtains an accuracy of 76.21%, Bi-LSTM obtains an accuracy of 77.58%, the BERT base method obtains an accuracy of 87.45%, BERT large obtains an accuracy of 89.13% and the CNN-LSTM method obtains an accuracy of 94%. From the results of the model comparison, it can be seen that the combination of the CNN-LSTM method obtains the highest accuracy in detecting public sentiment and emotions related to black lives matter.

In addition to the model architecture, text representation also plays an important role in ABSA's performance. Bidirectional Encoder Representations

from Transformers (BERT) is one of the most powerful word embedding methods, capable of capturing word context in both directions [6]. The use of IndoBERT adapted for Indonesian has been shown to improve model performance in various natural language processing tasks [7]. As shown in the study by Ng Chin et al. [43], the results of several scenarios show that the use of IndoBERT as an embedding is superior to Word2Vec. Therefore, based on the reference papers, this study supports the idea of using a combination of CNN-LSTM with BERT, focusing on the Indonesian language using IndoBERT in ABSA. The reference paper reinforces that the integration of pre-trained models such as IndoBERT with hybrid approaches such as CNN-LSTM can provide good performance results in aspect and sentiment analysis.

Based on the above background, this research focuses on applying the CNN-LSTM hybrid model with IndoBERT or trainable embedding layer word insertion to perform aspect-based sentiment analysis on Indonesian-language beauty product reviews to see the effectiveness of using the model from experimental results. The aspects used in this study are price, packaging, texture, and aroma.

The contributions of this research are outlined as follows:

- We annotated an Indonesian beauty product review dataset with four sentiment aspects: price, packaging, texture, and aroma, which can be used for this research.
- The research proposes an aspect-based sentiment analysist using CNN-LSTM and IndoBert model to improve the accuracy and provide deeper insights into consumer opinions on beauty products.

1.2 Statement of the Problem

How does CNN-LSTM with IndoBERT or trainable embedding layer model perform in extracting key aspects (such as price, packaging, texture, and aroma) and determining their sentiment from Indonesian beauty product reviews, and what are the differences in their performance as measured by the F1 score?.

The increasing number of online reviews of beauty products in Indonesia shows the need for aspect-based sentiment analysis to understand consumer

perceptions. This analysis helps identify several important aspects, and categorizes them into positive, neutral, and negative to be considered by consumers in choosing products and helps manufacturers to improve product quality, adjust marketing strategies, and design product innovations that are more in line with customer needs and preferences [2], [3], [4], [13],[14]. Although there have been several studies on beauty product reviews in Indonesian [14],[15], [39], [40], [41], [42], they are still limited to aspect-based sentiment analysis, especially in the CNN-LSTM method with IndoBert. Although the CNN or LSTM method has been widely used in sentiment analysis, CNN or LSTM have their respective shortcomings, where the CNN-LSTM approach offers advantages by combining the strengths of CNN in feature extraction and LSTM in understanding text context [9], [10], [11], [38]. In addition to the model architecture, we need to pay attention to word representation, such as IndoBERT which is able to capture the context of words in both directions that are specifically for the Indonesian language [6], [7], [12]. So, this study aims to answer the research question by analyzing Indonesian beauty product reviews using the CNN-LSTM method with IndoBERT.

1.3 Objective and Hypothesis

The main objective of this study is to develop a CNN-LSTM model with IndoBert as a word embedding for aspect-based sentiment analysis on indonesian beauty product reviews. This model utilizes the advantages of CNN in extracting features [8][11], and LSTM is used to overcome the limitations of CNN in capturing contextual relationships and dependencies [9], [10], [38]. In addition, this study utilizes IndoBERT as a word embedding method used in the model. BERT, as one of the leading word embedding methods, has been shown to excel in capturing context and semantics with a comprehensive bidirectional approach [6]. IndoBERT, which is a monolingual BERT variant for Indonesian, has shown superior performance in various natural language processing tasks [56][57]. Thus, this study is expected to prove that the CNN-LSTM hybrid method that utilizes IndoBERT is able to provide more accurate and comprehensive sentiment analysis results. This improvement is expected to be reflected in the F1 score[10].

1.4 Scope and Delimitation

The research carried out requires restrictions so that the implementation can be carried out properly. The problem restrictions in this study are as follows:

1. The dataset used is a review of beauty products on the Female Daily Network website.
2. Sentiment classification is divided into 3 classes, namely positive, neutral and negative.
3. The aspects used are price, packaging, texture and aroma.
4. The word embedding method used is Embedding layer from tenserflow or IndoBERT.
5. The model used is CNN and LSTM algorithm for combination as the classification method.
6. The output of this research is the combined f1-score results of the CNN and LSTM methods in classifying beauty product reviews on the Female Daily website.

1.5 Importance of the Study

This study addresses the limitations of Convolutional Neural Networks (CNN) in aspect-based sentiment analysis (ABSA) of beauty product reviews by using a hybrid CNN-LSTM approach. The goal is to classify the polarity of reviews as positive, neutral, or negative on specific aspects such as price, packaging, texture, and aroma. By integrating LSTM with CNN, this study aims to improve the model's performance in capturing complex contextual relationships, ultimately providing more accurate and actionable insights for businesses and consumers.