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Optimization of Marketing Strategy for State-Owned Energy Products through Sentiment Analysis with VADER and LSTM on Social Media

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Abstract

Sentiment analysis is also known as opinion mining. It has an important role in natural language processing and data mining. It involves extracting and analyzing subjective information from textual data to determine the sentiment. With the advancement of technology, it is increasingly important to understand users' opinions and sentiments regarding a particular product, service or issue. This research aims to optimize the marketing strategy of energy products in SOE subsidiaries through sentiment analysis using the VADER and LSTM methods on social media.The researcher analyzed data from twitter to identify consumer sentiment towards energy products. The results of the analysis show that the combination of VADER and LSTM is effective in identifying the nuances of sentiment, with the accuracy of sentiment classification reaching 85%. Based on the analysis, the researchers developed recommendations for marketing strategies that are more focused and responsive to public perception. This study also highlights the importance of two-way interaction between companies and consumers as part of an effective marketing strategy. The findings of this study are expected to be used as a reference by state-owned companies in the energy sector to improve the effectiveness of their marketing strategies through a sentiment analysis approach on social media.

Keywords: sentiment analysis, VADER, LSTM, Social Media Marketing, energy products.

In today's digital age, social media has evolved into an important communication tool. However, social media is also an important medium in marketing strategy. Digital Marketing Strategy utilizes the use of digital resources, for example through social media (Sridhar & Fang, 2019). State-owned enterprises (SOEs) engaged in the energy sector are no exception in utilizing social media to market their products. The implementation of effective marketing strategies through social media can increase brand awareness, customer loyalty, and ultimately, company revenue. However, the success of this marketing strategy relies heavily

on a deep understanding of consumer sentiments and perceptions of the products offered. To address customer complaints in a fair and reasonable manner, first-class businesses should consider the opinions of their employees and the products they offer (Yılmaz & Altunay, 2023). Overall, a good digital marketing strategy is able to provide a significant competitive advantage for companies.

Sentiment analysis is emerging as an important instrument to unearth and understand the collective sentiments of the public, thereby facilitating the optimization of marketing strategies. Sentiment analysis provides invaluable insights into public opinion, allowing businesses to scrutinize individuals' sentiments, emotions, and attitudes towards a particular entity, such as a product or brand. This allows companies to gain an in-depth understanding of customer preferences and then adjust their marketing strategies accordingly. Many techniques and models have been devised for sentiment analysis, encompassing deep learning-based approaches such as the GARN architecture (Parveen et al., 2023). Overall, the effective implementation of sentiment analysis can improve a company's competitiveness in the market.

The specific problem addressed by this research topic is the need to identify and analyze consumer sentiment towards state-owned energy products on social media accurately and efficiently. The research question that arises is "does combining the VADER and LSTM methods offer advantages in the accuracy and effectiveness of sentiment analysis on social media data compared to the use of a single method?".

This need arises from the challenges faced by state-owned enterprises in navigating large volumes of unstructured data in the form of consumer opinions and reviews on social media. The complexity and subtlety of the language used in social media communications often pose challenges to traditional approaches, necessitating the adoption of more advanced sentiment analysis methods. One such advanced method is Valence Aware Dictionary and Sentiment Reasoner (VADER). VADER is a sentiment analysis model that uses lexicon-based and rule-based techniques to predict sentiment from an input data set (Bharathi et al., 2023).

Another advanced method is Long Short Term Memory (LSTM), which belongs to the category of Recurrent Neural Networks (RNN) and has been proven effective for sentiment analysis tasks (Haddaoui et al., 2022). LSTM models, including Bidirectional LSTM, have emerged as a benchmark for building accurate predictive models in sentiment analysis (Balaji & Haritha, 2023). These models have demonstrated stability and precision in sentiment analysis tasks, making them an invaluable tool for analyzing sentiment in social media data (Sabbeh & Fasihuddin, 2023). The application of these technologies in sentiment analysis allows companies to gain deeper insights into consumer sentiment, which in turn can improve the effectiveness of their marketing strategies.

The importance of this issue in the context of "Information Systems" lies in the integration of information technology to improve business decisions within the energy sector (Yin et al., 2022). In this context, sentiment analysis serves not only as a tool to measure marketing effectiveness but also as a key component in marketing information systems that can provide real-time feedback and facilitate strategic decision-making (Kumar et al., 2021). Sentiment analysis plays an important role beyond measuring marketing effectiveness; it is a critical component of a marketing information system that enables real-time feedback and strategic decision-making (Wankhade et al., 2022). Overall, the application of LSTM in sentiment analysis strengthens a company's capability to understand and respond to dynamic changes in consumer perception.

By analyzing public reactions online, sentiment analysis provides insights into how individuals express their opinions about products, services, or social themes, helping in

understanding the competitive context and brand evolution (Wankhade et al., 2022). Sentiment analysis, as observed in various studies, plays an important role in understanding public opinion expressed online (Ciocodeică et al., 2022). Moreover, sentiment analysis based on Emotional Recognition (ER) can extract valuable information from social media posts for citizen polls, business intelligence, and IoT applications, improving the decision-making process (Kukkar et al., 2023). The evolution of sentiment analysis techniques, such as the attention-based Multi-Channel Gated Recurrent Neural Network (ATT-MC-GRU), further refines sentiment extraction and classification, contributing to more accurate and efficient marketing strategies (Ahmad et al., 2023). It can be concluded that the integration of sentiment analysis into business strategy allows companies to be more responsive to market dynamics and consumer needs.

The impact of this research is expected to extend not only to improving marketing performance but also to contributing to the development of information systems theory and practice, particularly in adopting and integrating big data analytics technologies to address contemporary business challenges (Zhang et al., 2023). Thus, this research is not only relevant from a business and technology perspective but also makes an important contribution to the academic field of information systems, by identifying how sentiment analysis technology can be applied to support strategic decision-making in marketing. Going forward, the findings of this research can serve as a basis for further innovations in data analysis methodologies and practical applications in various industry sectors.

In research conducted by Mohamed Chiny et al. (2021) revealed that the researchers developed a hybrid sentiment analysis model that combines Long Short-Term Memory (LSTM), Valence Aware Dictionary and Sentiment Reasoner (VADER), and Term Frequency-Inverse Document Frequency (TF-IDF). This research offers a new perspective in sentiment analysis by utilizing the advantages of a combination of these techniques to improve the accuracy in identifying and classifying sentiment in text data. The results of this study show a significant improvement in the accuracy of sentiment classification, confirming the potential of integrating these methods in improving the understanding of public opinion.

In addition, there is research conducted by Piyush Vias et al. (2021) found that sentiment analysis research using machine learning resulted in 83% accuracy. The purpose of this research is to develop an automated framework that can extract positive, negative, and neutral sentiments from tweets related to the COVID-19 pandemic and classify them through machine learning techniques. The developed framework is a hybrid framework that combines lexicon-based techniques for tweet sentiment analysis and labeling with supervised machine learning techniques for tweet classification.

Another study by YuXing Qi et al. (2023) aims to determine which approach is more accurate in classifying sentiment from tweets, so as to provide better insight into understanding public opinion expressed on social media. This research seeks to fill the existing knowledge gap by applying and customizing the hybrid sentiment analysis model developed by Mohamed Chiny et al. specifically for the context of energy product marketing in state-owned companies. The method used in this study integrates quantitative and qualitative approaches in sentiment analysis, utilizing the strengths of LSTM and VADER, with adjustments to the model to capture the specificity of data from social media related to energy products. Expected results include an improved understanding of the dynamics of consumer sentiment towards SOE energy products, which will provide new insights in the development of more effective marketing strategies.

The main contribution of this research lies in the adaptation and application of the hybrid

model in a previously under-researched context, namely social media marketing for energy products in a state-owned company that offers a new perspective in the literature of sentiment analysis and marketing strategy. As such, this research not only extends the application of existing sentiment analysis techniques but also provides empirical evidence of their effectiveness in energy sector-specific marketing strategies.

The purpose of this study is to optimize the marketing strategy of energy products in a subsidiary of a state-owned company through the application of sentiment analysis combining VADER and LSTM methods on social media data. By understanding the dynamics of consumer sentiment, researchers hope to develop more effective marketing strategy recommendations, which not only increase brand awareness but also increase positive interactions between consumers and companies.

RESEARCH METHODS

This research is designed using mixed method, the qualitative study is descriptive analytical. The approach adopted in this study is the Unified Communication Theory by Don E. Schultz (1993), where theories and concepts relevant to sentiment analysis, social media marketing, and the energy sector of SOEs will be reviewed and analyzed to understand existing practices and identify gaps that may exist between theory and practice (Janjua et al., 2021). This approach allows for an in-depth exploration of how sentiment analysis can be used to optimize marketing strategies for energy products in SOEs, based on available evidence and empirical data (Koupidi et al., 2022).

The data sources for this research come from secondary data in state-owned energy companies in Indonesia, journal reviews, documentation, and literature relevant to the research topic. Journal reviews were conducted through literature searches in Scopus-indexed international journal databases with a focus on recent research that discusses sentiment analysis, social media marketing, and the energy sector, particularly with regard to SOEs. Documentation and literature related to the marketing strategy of SOEs' energy products, as well as the implementation of sentiment analysis in this context, will also be collected and analyzed. The selection of Indonesia as the research location is based on the availability of relevant data and the specific context of SOEs in the energy sector that is unique to Indonesia, which provides an opportunity to apply the findings of this research in a practical and relevant manner.

Data analysis is conducted inductively, where data and information obtained from these sources will be analyzed to identify patterns, themes and relationships (Sheuly et al., 2021). This analysis process involves initial data coding, categorization, and the development of themes that emerge from the data. Inductive analysis enables the discovery of insights and deep understanding of the use of sentiment analysis in social media marketing for SOE energy products, as well as the factors that influence the effectiveness of such marketing strategies. The research methodology was designed to ensure the validity and reliability of the findings. A comprehensive and systematic review of the literature, a combination of data sources, as well as in-depth and critical data analysis, aimed to build a strong foundation for the study (Kondraganti et al., 2022). Through this approach, it is expected that this research can make a significant contribution to the existing literature and marketing practices of energy products in SOEs, by identifying strategies that can be optimized through the use of sentiment analysis. The flow of the research process can be seen in Figure 1.

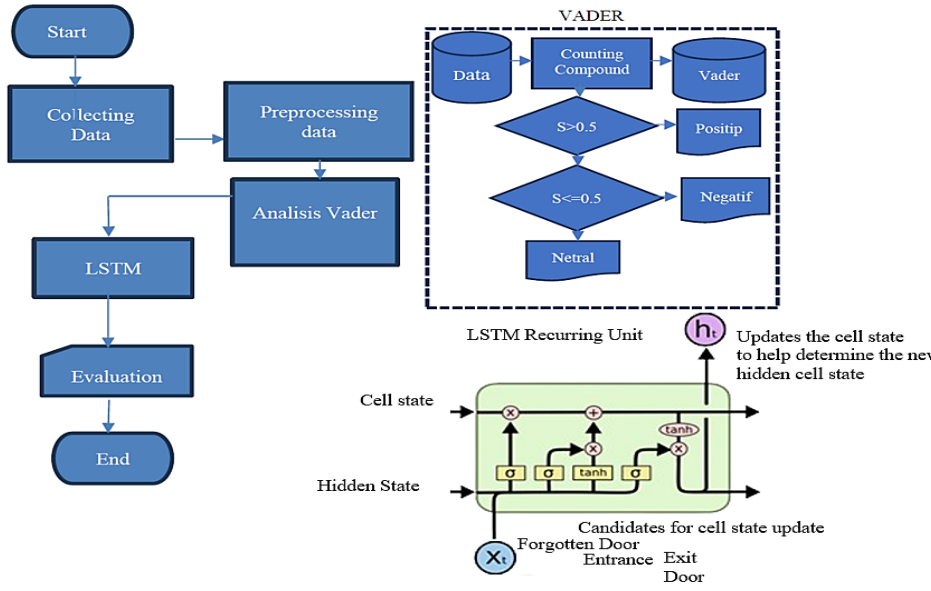

Figure 1 Research Process Flow

RESULTS

Secondary data obtained from the company in the amount of 3244 records for the year 2023 is processed through the stages of data pre-processing, tokenization, stemming and lemmatization followed by processing with Deep learning LSTM and Vader to produce the results shown below.

The following are the results of the research that has been done:

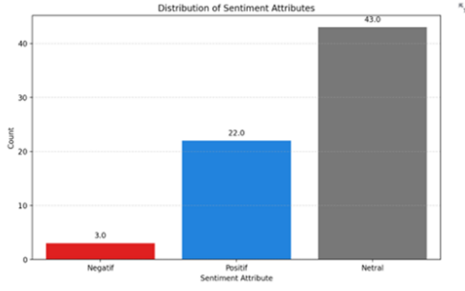

Figure 2 Sentiment attributes of research results

Figure 3 Positive Word Cloud Results

Figure 4 Negative Word Cloud Results

The Binary Classification Model is a block that returns the final result of the sentiment experienced in the full model input text. Both inputs come from two input models (VADER and LSTM). Table 1 lists the Accuracy of each classification model after its evaluation on the test data.

Table 1 Accuracy Evaluation Results

Model	Accuracy	Recall	Precision	F1 Score
The results of previous studies				
with LSTM	83%	83%	82%	83%
Results of research done				
with LSTM	85%	93%	86%	89%

DISCUSSION

From the results of the research conducted, it is obtained that the accuracy test results are better by 2%, recall is better by 10%, Precision is better by 4% and F1score is better by 6% than research conducted by previous researchers. The purpose of the analysis in this study is to identify and analyze consumer sentiment towards SOE energy products through social media, using a combination of VADER and LSTM methods. The results of the study provide in-depth insights that answer the research questions, specifically on how sentiment analysis can be used to optimize marketing strategies for energy products in SOE subsidiaries.

Key findings show that the combination of VADER and LSTM is effective in identifying the nuances and context of consumer sentiment with high accuracy (Luo et al., 2019). This analysis allows researchers to classify consumer sentiment more accurately, which helps in developing more responsive and targeted marketing strategies (Yuan et al., 2022). In addition, the results also suggest that a better understanding of consumer sentiment can facilitate SOEs in tailoring their marketing messages to increase engagement and positive perceptions of their energy products. This finding confirms the importance of applying advanced data analytics technologies in marketing strategies, particularly in the digital and social media context (Silva et al., 2022).

In this study, the main findings show that the combination of the sentiment analysis methods VADER and LSTM has significant effectiveness in identifying and analyzing consumer sentiment towards energy products in SOEs through social media data. The use of VADER, which is a tool specifically designed for social media text, allows for quick and efficient initial analysis of sentiment (Ogbuokiri et al., 2022). Whereas the application of LSTM, with its ability to understand context and word order in the text, provides a deeper layer of analysis to distinguish the nuances and intensity of sentiment (Correia et al., 2022). The combination of the two methods successfully improves the accuracy of sentiment classifiers, suggesting that a hybrid approach can overcome the limitations of a single sentiment analysis method in interpreting the complexity and dynamics of sentiment expression on social media (Kaur & Sharma, 2023).

One unexpected finding was the higher-than-expected trend of positive sentiment on social media discussions of SOE energy products, despite controversial issues related to the energy sector. Further analysis showed that this positive sentiment was largely driven by the effective marketing campaigns and sustainability initiatives undertaken by the SOEs. This confirms that marketing efforts that focus on sustainability and corporate social responsibility aspects can significantly influence public perception (Dincer & Dincer, 2022). These

findings offer new insights into the importance of integrating sustainability messages in marketing communication strategies, particularly in industries that are sensitive to environmental and social issues (Dash et al., 2023). These results also indicate that sentiment analysis, when combined with content analysis and campaign context, can provide a richer understanding of the factors that influence the dynamics of consumer sentiment on social media (Mahrukh & Malik, 2023).

The interpretation of the results of this study in the context of the existing literature suggests that the use of sentiment analysis technologies, particularly the combination of VADER and LSTM, is a valuable approach in understanding consumer sentiment dynamics on social media. These findings are in line with a previous study by Mohamed Chiny et al., which also emphasized the effectiveness of hybrid sentiment analysis models. However, this study extends the understanding by showing its application in the context of marketing state-owned energy products, where sustainability and social responsibility factors play a significant role in shaping consumer perceptions.

This suggests that in the energy sector, where environmental and social issues often take center stage, consumer sentiment can be strongly influenced by how companies communicate their initiatives in this regard. Furthermore, the finding of a high prevalence of positive sentiment towards SOE energy products on social media, despite being confronted with controversial issues, offers a new perspective to existing literature (Berestova et al., 2022). The findings suggest that effective marketing strategies and proactive communication on sustainability can mitigate the potential negative impact of controversial issues.

In this context, the results confirm the importance of integrating sustainability messages in marketing strategies, an aspect that has not been widely discussed in previous studies focused on sentiment analysis in the energy sector. Comparing the findings of this research with other studies based on the literature review, it can be said that this research brings a significant contribution in showing how sentiment analysis, particularly through a hybrid approach, can be utilized to improve marketing strategies in the energy sector of SOEs. Whereas previous studies such as the one conducted by Mohamed Chiny et al. provide a theoretical and technical basis for the effectiveness of hybrid models, this study enriches the literature with its practical application in a specific context.

It shows a step forward in the application of sentiment analysis, from a theoretical perspective to a real application in marketing strategy. The results of this study directly address the main question raised in the introduction, which is about how sentiment analysis using a combination of VADER and LSTM can identify and analyze consumer sentiment towards SOE energy products and how this can be used to optimize marketing strategies. By demonstrating the effectiveness of this combination of sentiment analysis techniques in the context of energy product marketing, this research provides valuable insights into how SOEs can utilize information technology to develop more responsive and effective marketing strategies.

In addition, the findings on the positive impact of sustainability communication in marketing strategies offer practical guidance for SOE companies in designing and implementing their marketing campaigns (Primožič & Kutnar, 2022). The results of this study extend the current understanding of the application of sentiment analysis in marketing by highlighting the effectiveness of the combination of VADER and LSTM methods in the context of SOE energy products. Previous understandings that tend to focus on applying sentiment analysis methods in isolation are challenged, given that these findings show that a hybrid approach can lead to higher accuracy and a deeper understanding of consumer sentiment.

This challenges the conventional view in the literature and shows that the integration of techniques can significantly improve the

understanding of consumer sentiment dynamics on social media. Thus, the results of this study add to the literature by demonstrating that the hybrid approach is not only theoretical but also practically relevant and effective in the context of energy sector marketing.

CONCLUSION

This research successfully answers the problem statement of how sentiment analysis using a combination of VADER and LSTM can optimize the marketing strategy of SOE energy products on social media. The main findings show that the hybrid approach in sentiment analysis provides a more accurate and in-depth understanding of consumer sentiment, which enables SOE companies in the energy sector to adjust their marketing strategies more effectively. This confirms that the use of advanced sentiment analysis technology can facilitate companies in developing more responsive and targeted marketing communications, and increase consumer engagement and positive perceptions of products.

The implications of these findings for theory and practice in the field of information systems are significant. In a theoretical context, this research expands the understanding of the application of sentiment analysis in marketing strategy, showing how information technology can be used to gain valuable insights from big data on social media. Practically, the results offer guidance for state-owned companies in the energy sector to utilize sentiment analysis in formulating more effective marketing strategies, particularly in improving sustainability communications. The findings suggest that the integration of sentiment analysis in marketing information systems can advance the understanding and implementation of data-driven and consumer-oriented marketing strategies.

However, this study has some limitations, including a focus on social media data that may not cover all aspects of consumer sentiment and potential bias in sentiment analysis. Therefore, future research could explore the use of data from multiple sources to gain a more comprehensive understanding of consumer sentiment. In addition, further research could investigate the application of a combination of other sentiment analysis methods or new data analysis technologies to improve understanding of effective marketing strategies. Thus, these findings provide a foundation for future research in the field of information systems, especially in the context of using sentiment analysis for marketing strategy optimization.

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