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Original Article

Implementation of a Web System with Machine Learning for Sentiment Analysis in Social Networks for the Marketing

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Abstract *- This research work aims to implement a web system that uses Machine Learning through sentiment analysis in social networks for the marketing area of the company D'Onofrio. The main objective is to apply sentiment analysis techniques to identify the opinions and needs of consumers and to increase the effectiveness of marketing tactics and the decision-making process. The methodology employed combines natural language processing tools and machine learning algorithms to analyze user-created content on social media platforms. Relevant data on perceptions and emotions associated with the D'Onofrio brand and consumer preferences and demands will be collected. The legal framework will be based on the laws and regulations applicable in the Peruvian context, ensuring that privacy and personal information safeguarding requirements are met. The results of this study will provide valuable information to the company D'Onofrio about consumer perceptions on social networks, allowing for more informed decision-making in implementing effective marketing strategies tailored to the target audience's needs. In conclusion, the application of machine learning through sentiment analysis in social networks represents a promising opportunity to improve consumer understanding and strengthen the relationship between the company and its audience.*

Keywords *- Sentiment analysis, Machine learning, Web system, DMAIC, Kanban.*

1. Introduction

Currently, sentiment analysis in social networks is experiencing an increase due to the growing relevance of communication platforms between companies and consumers. Thus, due to the increased use of social networks, large amounts of user-generated data are generated, including opinions, comments and emotions expressed in relation to a product, service, or experience. In [1] mentions that by 2019, there were around 2770 million users on major social media platforms globally, so a large amount of raw data can be turned into valuable and useful data for organizations.

In addition, due to this growth, the most popular social networks such as Twitter, Instagram and Facebook have become a major component in people's daily lives because it is used to meet new people and share information with each other. This is where we find the connection between social networks and the study of emotions or sentiment analysis for this research; [2] to effectively understand a social network, sentiment analysis has become an essential tool to understand users' perceptions and emotions. Because it is used to express opinions or feelings related to a company's products or services through comments on publications. So, [3] highlights the importance of making use of the information generated by the users themselves on social media platforms; also, the application of sentiment analysis is used in other areas such as health care, movies, products, and politics, among others. The problem identified in this research work is the difficulty in decision-making in the marketing area of the company D'Onofrio since it does not have the appropriate tools for a quick and clear analysis of relevant information about the opinion of their products in social networks for the current processing of this information several manual and non-automated activities are used, which demand time and can present human failures. [4, 5] tells us that Artificial Intelligence is being applied to the marketing sector and is attracting more and more attention from scholars in this field.

In the current situation, social networks play an essential role in the communication between companies and their customers. Sentiment analysis in each social network has become a valuable tool for understanding the opinions and emotions of consumers. In this sense, this research focuses on sentiment analysis in social networks aimed at the marketing area of the D'Onofrio company in the food sector.

Using sentiment analysis techniques in social networks will allow D'Onofrio to understand its consumers' perceptions

and preferences better. To achieve this, the collection and analysis of social media data will be carried out to identify the sentiments expressed towards the products and the brand. In addition, using artificial intelligence and natural language processing tools and algorithms implemented in Python programming language will facilitate automation and efficiency in analysing vast volumes of data. Therefore, [6] indicates that using machine learning techniques in sentiment analysis in social networks has proven effective in identifying and classifying consumer opinions. What [7] mentions is that the data generated on the web by users brings sentiment analysis into focus as an important topic to touch upon.

Social media sentiment analysis applied to D'Onofrio's marketing area also has significant social relevance. The company can demonstrate a genuine commitment to customer delight and constant progress by paying attention to and understanding customer perceptions on social media platforms. This will strengthen the company-customer relationship, build trust, and contribute to building a positive brand image. Furthermore, by tailoring its products and services to customers' preferences and requirements, D'Onofrio will be helping to deliver more satisfying experiences and promote quality in the food industry. Thus, the objective of the research is to implement a web system with machine learning to perform sentiment analysis in social networks in the marketing area of the company D'Onofrio, to identify the opinions and demands of customers, and to improve the effectiveness of marketing strategies.

2. Literature Review

In this section, the research carried out by different international and national researchers on the topic of sentiment analysis in social networks will be developed. This will allow us to consider the findings, their results, and conclusions in relation to the present research carried out.

According to [8], a consumer sentiment analysis model has been developed using deep learning techniques, which have proven highly effective. Hence, using Natural Language Processing (NLP) methods and a Long- and Short-Term Memory (LSTM) neural network in a hybrid feature extraction approach has yielded promising results. Moreover, using an LSTM neural network in sentiment classification has led to exceptional results in terms of accuracy, recall and F1 score. This demonstrates the ability of the proposed model to identify and classify emotions and opinions expressed by consumers properly.

These findings are highly relevant to business owners, providing valuable insight into how consumers perceive their products, brands or services. By better understanding their customers' preferences and behaviors, business owners can make informed and strategic decisions to improve their relationship with consumers and meet their needs more effectively.

On the other hand, [9] addresses the analysis of interactions in the social network Twitter and mentions the use of Sentiment Analysis in Social Platforms to unravel the behavioral patterns of users on this platform. Through a targeted and weighted network, valuable insights into discussion topics and connections between users were revealed. The results highlight the importance of building social networks focused on specific topics to identify influential users and understand group dynamics. In addition, the PageRank algorithm was shown to be highly effective in measuring individual influence. Although the study also explored the identification of communities, the results were more mixed on this aspect. Overall, this approach to social network analysis offers a robust and replicable methodology for understanding Twitter dynamics and can be easily automated.

Similarly, [10] presents an intriguing proposal that addresses the challenge of sentiment analysis on Twitter. By combining feature selection and deep learning techniques, a significant improvement in the accuracy and efficiency of the system is achieved. The proposed approach stands out for its ability to identify and classify different sentiments expressed in tweets, providing a deep understanding of users' opinions. The results obtained are impressive, with high F1 accuracy and score values, supporting the effectiveness of this architecture in Twitter sentiment analysis. This innovative approach can potentially provide valuable insights into user perception and attitude on social networks.

According to [11], their review determined that modern linguistic algorithms converge towards brain-like solutions, which opens a promising avenue in natural language processing. Also, [12] mention that in the last decades, natural language processing has attracted a large number of developers and scientists who have made available a large number of libraries, tools, and scripts to handle low-level processing (Tokenization, PoS tagging) as well as high-level processing (document classifiers, models).

According to the study [13], they mention that massive data analysis was carried out on the social networking platform Twitter with the purpose of recognizing or detecting opinions; they propose to use machine learning techniques, as well as natural language processing methods, by means of text-based processing with sentiment analysis and Machine Learning. On the other hand, these technologies were used to express opinions and feelings about any aspect of society; that is why companies have grasped the importance of collecting and analyzing the opinions and feelings of users or customers of organizations through social platforms. To better understand, in the research conducted by the author, different tools and techniques were implemented to identify massive opinions of users on the Twitter platform, and the purpose was to obtain results of positive or negative classification on any topic interacted in this social network.

In the research conducted by the author cited in [14], he discusses the techniques of sentiment analysis in journalistic articles and social networks since there were manual procedures that hindered the results of the sentiments expressed in texts, which made them unreliable. That is why, in this research, it was proposed to use deep learning techniques to automate the task of analyzing the feelings and opinions of journalistic articles and social networks through an algorithmic model.

The problem identified by the author reflects the importance of automated processes in the journalistic media since manual processes should be left aside and new technologies should be used to identify new organizational needs, in this case, the identification of opinions through sentiment analysis, also known as opinion mining.

On the other hand, [15, 16] mentions in his article on the implementation of sentiment analysis in the political sector through the social network Twitter, where sentiment segmentation techniques based on machine learning are used, with the purpose of identifying patterns and behavioral trends among Twitter users during an electoral process. Therefore, it can have an impact on the results of such a process due to the identification of the feelings and emotions expressed by users.

This shows the great importance of sentiment analysis, as it can be applied to any sector of society, even in the political arena, due to the large amount of information stored in social networks, as it is an environment where thousands of users interact and share information or opinions with each other.

In summary, research and studies conducted by different international and national researchers support the effectiveness of sentiment analysis in social networks. These studies demonstrate that natural language processing methods, deep learning, and social network analysis can provide valuable insights into user opinions and emotions on platforms like Twitter. These findings are relevant for companies, as they allow them to understand better the perception that users have about their products or services and thus make informed decisions to improve their relationship with customers. However, there are still some gaps in relation to new areas of sentiment analysis implementation, such as in the food industry. That is why, in this research work, a web system with machine learning for sentiment analysis on social media platforms will be implemented for the marketing area of the company D'Onofrio.

3. Methodology

In this research work, the Kanban and Lean Six Sigma methodology will be applied; the combination of both will be used because, on the one hand, Kanban will be used to track the status of the project, and Lean Six Sigma will apply the analysis and continuous improvement process. In the Kanban methodology, a visual board will be used, with columns to do, process, review and complete. On the other hand, the Lean Six Sigma methodology has 5 steps of DMAIC Figure 1.

3.1. Lean Six Sigma

According to [17], they indicate that the Lean Six Sigma methodology is a mix between Lean, which is an approach in which waste is eliminated and continuous improvement is sought, and Six Sigma, which focuses on reducing variation and defects in processes through the use of statistical techniques based on the DMAIC structure.

3.2. Define

In this phase, as mentioned [18], the problem and the objectives to be achieved are identified or defined; this phase is vital because if the problem is not adequately identified, it may affect the correct analysis and, therefore, the findings achieved. In this first stage of the DMAIC, the definition will be carried out, where the objective is to understand, delimit and establish the study problem. The empathy map will be made to achieve this phase's objective.

3.3. Measure

As mentioned by [19], this phase consists of measuring the key aspects of the current process, as well as collecting the relevant data and calculating the process capability. Therefore, we used a sample of the last year regarding the work being done by Marketing and its ability to provide information regarding campaigns and products to the steering committee.

3.4. Analyze

According to [20], the causes responsible for the poor quality or variability of the existing process are identified in the analysis phase.

3.5. Improve

According to [21], the improvement phase addresses the root cause and makes changes to eliminate the problem that causes variability and waste in the process.

3.6. Control

In the last phase of the DMAIC, it is applied according to [22, 23] that the implemented changes are maintained and sustainable, as well as a follow-up of the results.

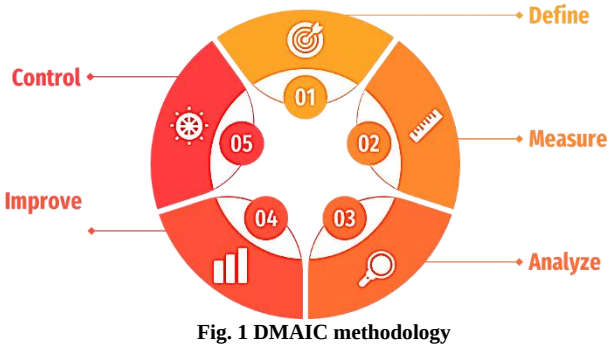

Fig. 1 DMAIC methodology

Table 1. Kanban board

Kanban Board	Description
To be Done	This column shows the tasks that have not yet been started. So, they are waiting to be assigned and prioritized.
In Process	In this column are the tasks on which the team is working.
Review	This column contains all the tasks that have been completed in the "in progress" column, and here, it is verified that the task meets the established requirements.
Completed	This column shows all the tasks that have passed the review stage, so only the completed tasks are displayed.

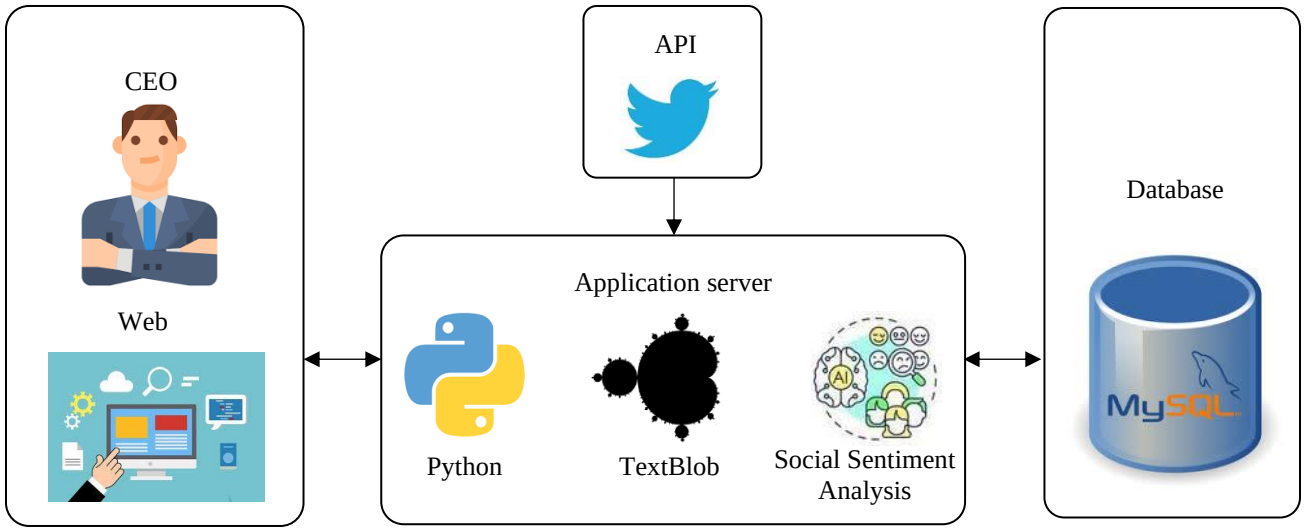

Fig. 2 Software architecture

3.7. Kanban

Kanban, in the words of [24], mentions that it is designed for transparent workflow management by visualizing the current status of each work item for the purpose of the system. Thus improving efficiency in the flow by limiting the amount of work in progress and optimizing responsiveness.

In Table 1, with this methodology, a Kanban board will be created to visualize the workflow and the different stages of the project. Therefore, the board will be divided into columns that represent the different stages and activities of the project, where they are categorized by individual cards consisting of a list of tasks.

3.8. Software Architecture

Figure 2 illustrates the system architecture, where each system layer's elements are defined. The first layer is the client, which refers to the interface used by users to interact with the system. In the second layer, the server is responsible for managing client requests, the Twitter API, and the technologies to be used. Finally, in the third layer is the database, where the collected data will be stored and managed.

3.9. Flow Diagram

Figure 3 shows the flowchart of the implementation. This process starts with the source text in the data cleaning procedure, where noise is identified, normalization, data masking and finally, the text is cleaned. Therefore, linguistic processing is considered.

As indicated in the flowchart, there are two main processes; in the first Data cleaning process, there is the following list of steps:

a) Api Source Text: this step involves obtaining the source text for sentiment analysis using an API (Application Programming Interface).
b) Identify Noise: In this stage, irrelevant or unwanted text elements such as special characters, punctuation marks, numbers or symbols are identified and removed.
c) Noise Removal: Here, effectively removing the noise elements identified in the previous step is performed, cleaning the text of any unwanted content.
d) Character Normalization: This step seeks to normalize the characters in the text, for example, by converting letters with accents or diacritics into their unaccented equivalents.
e) Data Masking: In this step, certain sensitive or confidential data elements in the text, such as proper names or personal information, are hidden or masked.
f) Clean Text: Here, additional text cleaning is performed, removing any remaining unwanted elements and preparing the text for further processing.

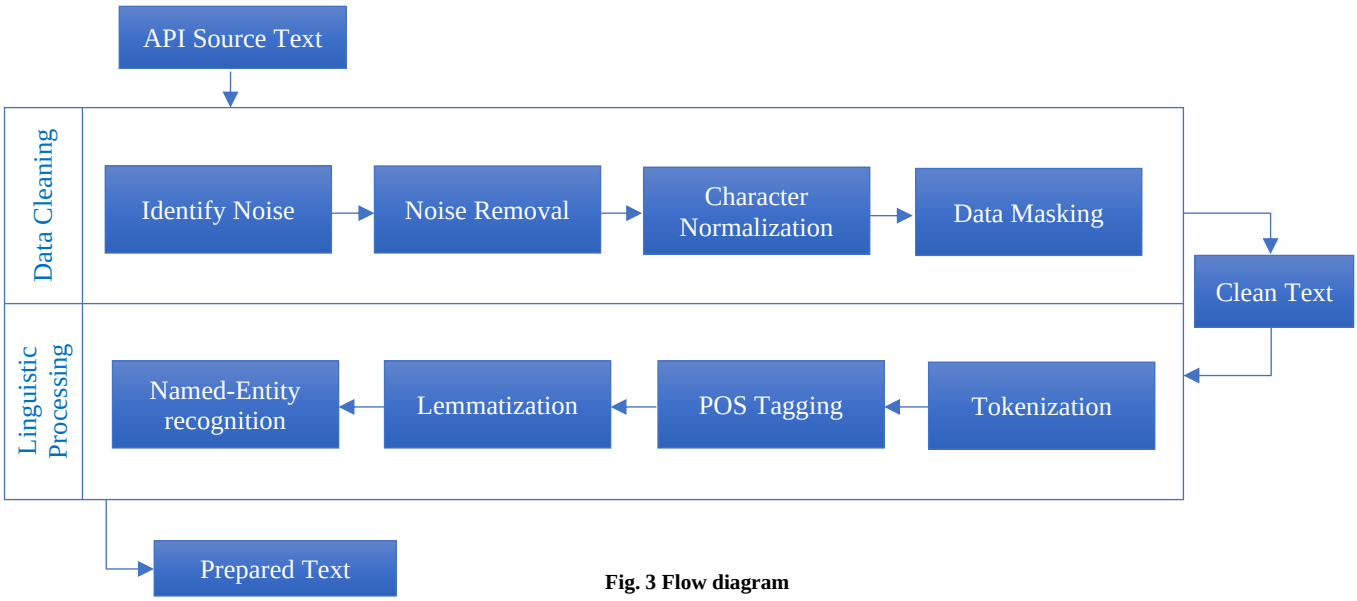

Fig. 3 Flow diagram

Therefore, in the second process of linguistic processing, there is also a series of steps, which are explained below:

a) Tokenization: In this step, the text is divided into smaller units called tokens, which can be individual words or even shorter sentences, facilitating further analysis.

b) PoS Tagging: Here, a Part-of-Speech (PoS) tag is assigned to each token, which helps to understand the function and meaning of the words in the context of the text.

c) Lemmatization: In this step, words are converted into their base or root form, which facilitates analysis by reducing the different inflected forms of words to a common form.

d) Named Entity Recognition: This step involves identifying and labeling named entities in the text, such as names of people, organizations, locations, dates, etc.

e) Prepared Text: At the end of the process, the prepared text is obtained, cleaned, tokenized, grammatically tagged, lemmatized, and recognized by named entities. This prepared text can be used in sentiment analysis or other natural language processing tasks.

```
model.py
# Divides data into training and test set
X_train, X_test, y_train, y_test = train_test_split(data['text'], data['aspect_sentiment'], test_size=0.2,
random_state=42)

# Load the BERT tokenizer
tokenizer = BertTokenizer.from_pretrained('bert-base-uncased')

# Tokenizes texts and converts them to pytorch tensors.
X_train_tokens = tokenizer(list(X_train), padding=True, truncation=True, return_tensors='pt',
max_length=256)
X_test_tokens = tokenizer(list(X_test), padding=True, truncation=True, return_tensors='pt', max_length=256)

# Create dataloaders for training and testing
train_data = torch.utils.data.TensorDataset(X_train_tokens.input_ids, X_train_tokens.attention_mask,
torch.tensor(y_train))
train_loader = torch.utils.data.DataLoader(train_data, batch_size=16, shuffle=True)

test_data = torch.utils.data.TensorDataset(X_test_tokens.input_ids, X_test_tokens.attention_mask,
torch.tensor(y_test))
test_loader = torch.utils.data.DataLoader(test_data, batch_size=16, shuffle=False)

# Load the pre-trained BERT model for sequence classification.
model = BertForSequenceClassification.from_pretrained('bert-base-uncased', num_labels=2)
```

Fig. 4 Machine learning model 1

```python
# Optimizer definition and loss function
optimizer = torch.optim.AdamW(model.parameters(), lr=2e-5)
loss_fn = torch.nn.CrossEntropyLoss()

# Model training
model.train()
for epoch in range(5):
    for batch in train_loader:
        input_ids, attention_mask, labels = batch
        optimizer.zero_grad()
        output = model(input_ids, attention_mask=attention_mask)[0]
        loss = loss_fn(output, labels)
        loss.backward()
        optimizer.step()

# Evaluation of the model
model.eval()
predictions = []
with torch.no_grad():
    for batch in test_loader:
        input_ids, attention_mask, _ = batch
        output = model(input_ids, attention_mask=attention_mask)[0]
        _, predicted_labels = torch.max(output, 1)
```

Fig. 5 Machine learning model 2

```python
        predictions.extend(predicted_labels.cpu().numpy())

accuracy = accuracy_score(y_test, predictions)
print('Precisión del modelo: {:.2f}%'.format(accuracy * 100))
print(classification_report(y_test, predictions))
```

Fig. 6 Machine learning model 3

3.10. Machine Learning Model

Figures 4, 5 and 6 show the model code, where the implementation of aspect-based sentiment analysis using the BERT (Bidirectional Encoder Representations from Transformers) model in Python is presented. BERT is a pre-trained language model that has demonstrated outstanding performance on various natural language processing tasks, including sentiment analysis. In this implementation, the Transformers library from Hugging Face is used to load the pre-trained BERT model and the corresponding tokenizer. Then, the data is split into training and test sets, and the texts are tokenized and converted into PyTorch tensors. The model is then trained using a BERT sequence classifier with a linear kernel, and its performance on the test set is evaluated using accuracy measures and a classification report. This implementation provides an efficient and powerful solution for analyzing sentiment based on specific aspects of the text, which can be very useful for understanding user opinions about products or services.

The code implements a sentiment analysis model using BERT, a pre-trained language model known for its effectiveness in natural language processing. First, the data is divided into training and test sets. Then, texts are tokenized using the BERT tokenizer and data loaders are created to train and evaluate the model. A pre-trained BERT model is used for sequence classification, and training is performed for 5 epochs with a specific optimizer and loss function. Finally, the model's accuracy and a detailed classification report highlighting the model's performance on different sentiment classes are shown.

3.11. Prototypes

The web system development prototypes are shown from the access to the website to the dashboard with the search results. Figure 7 shows the initial interface of the web system, where it is possible to enter the product or service to be evaluated.

Fig. 7 Startup screen

Figure 8 shows the results derived from the search performed previously on the home screen. Here, you can see some of the analyses performed.

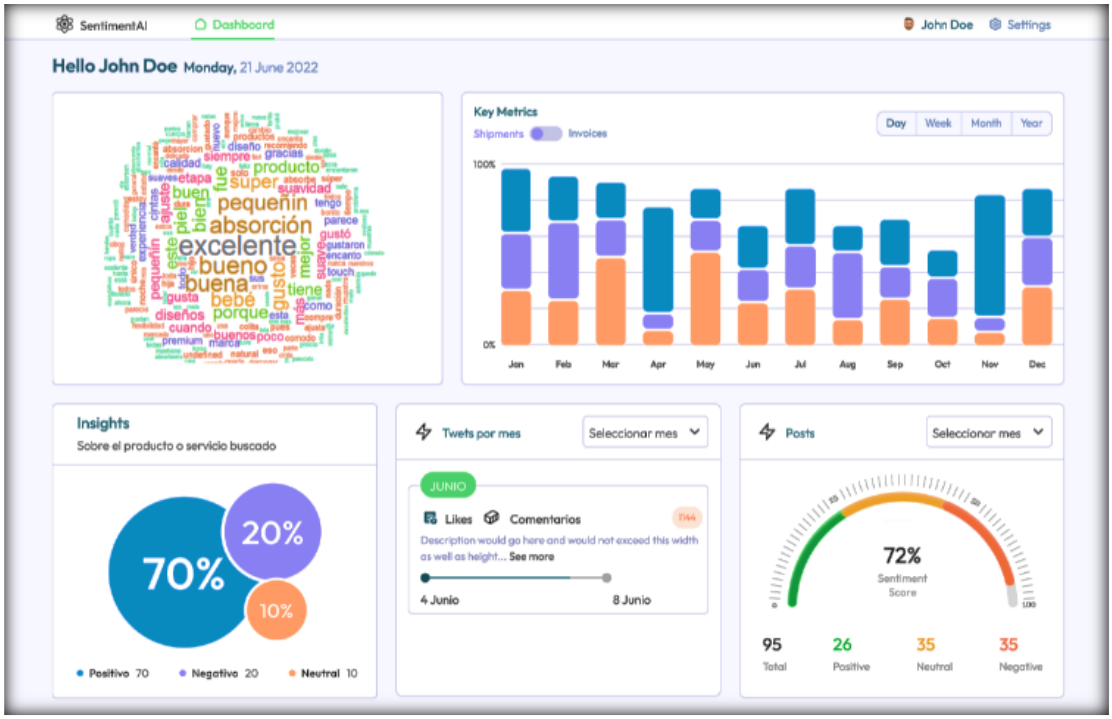

Fig. 8 Results screen

4. Results and Discussions

4.1. About the Survey

A series of questions were elaborated for a sample of 25 people who are consumers of the D'Onofrio brand to know their opinion about the brand's preferences, as well as questions about their expectations regarding the efficiency of the web system. A list of the questions asked in the survey is presented in Table 2.

Table 2. Survey

IMPLEMENTATION SURVEY
What is your gender?
How much time do you spend on social networks each day?
What are the main social networks you use?
How often do you interact with posts about the D'Onofrio brand on social networks?
Have you purchased D'Onofrio products based on information or promotions you saw on social networks?
What is your overall opinion of D'Onofrio's social media presence?
What type of D'Onofrio content do you find most engaging on social media?
Have you ever shared D'Onofrio-related content on your social networks?
What is your perception of D'Onofrio's products' quality compared to similar brands?
Do you feel that D'Onofrio responds adequately to customer comments or queries on social networks?
Do you think that the use of sentiment analysis in social networks can help D'Onofrio to better understand the needs and opinions of its customers?
The following image shows a prototype which uses artificial intelligence to validate the latest comments on social networks regarding a product or service.
What do you think of the design and usability of the prototype presented below?
Would you like to receive exclusive offers or promotions from D'Onofrio through social networks?
Do you trust the information D'Onofrio shares on its social networks?
Would you recommend D'Onofrio's products to your friends or family based on your social media experience?

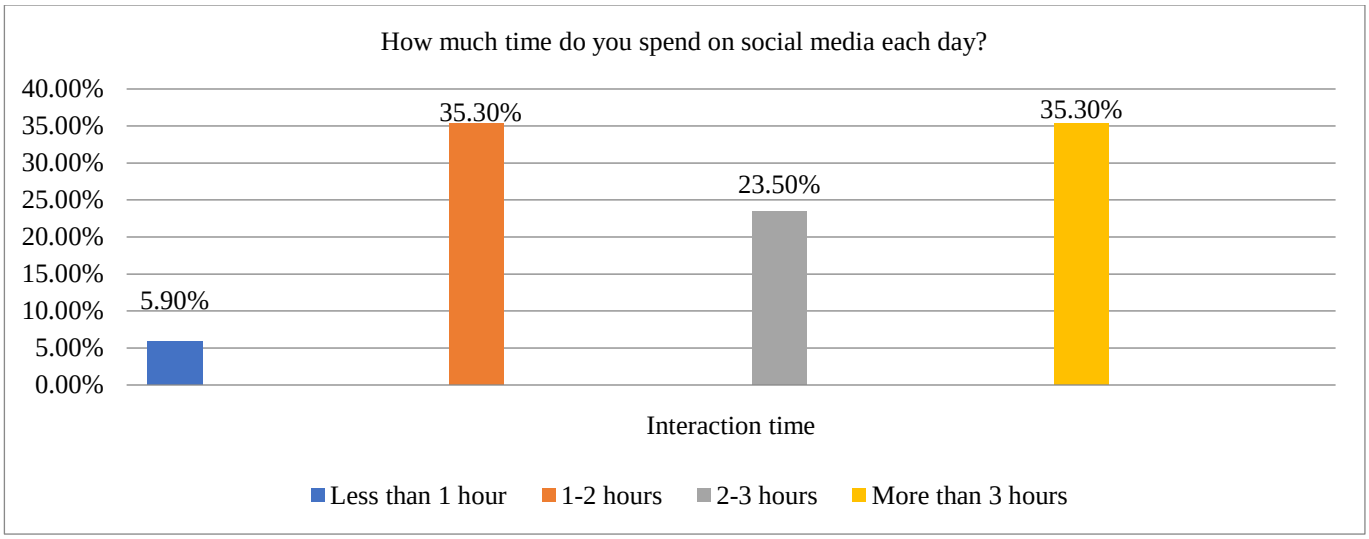

Fig. 9 Time spent on social networks

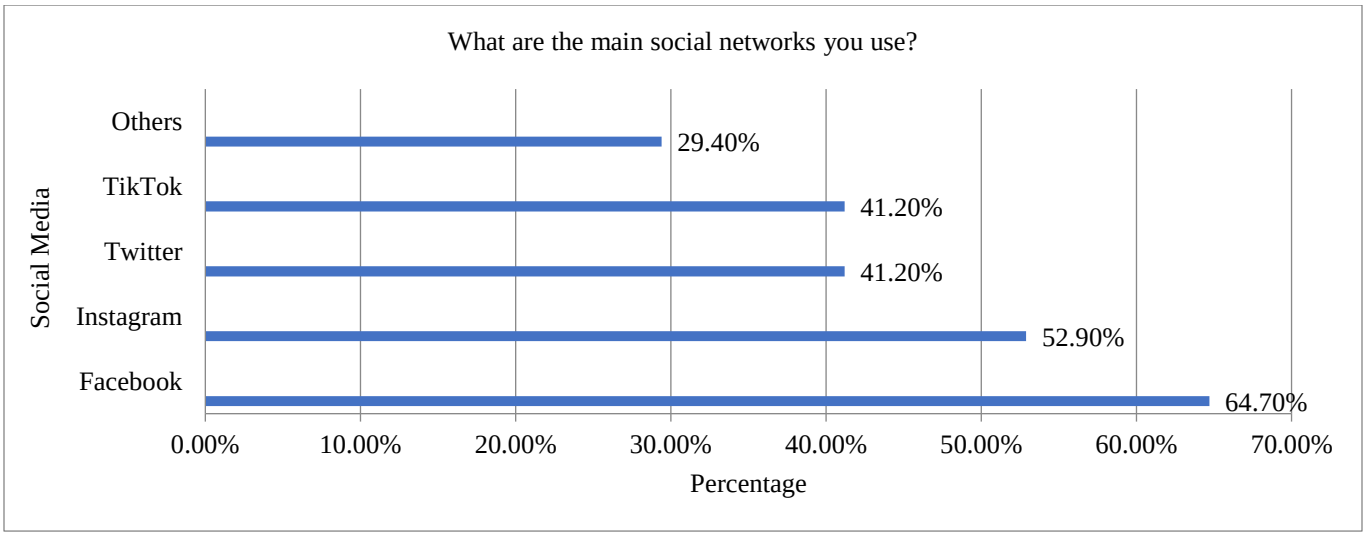

Fig. 10 Social networks

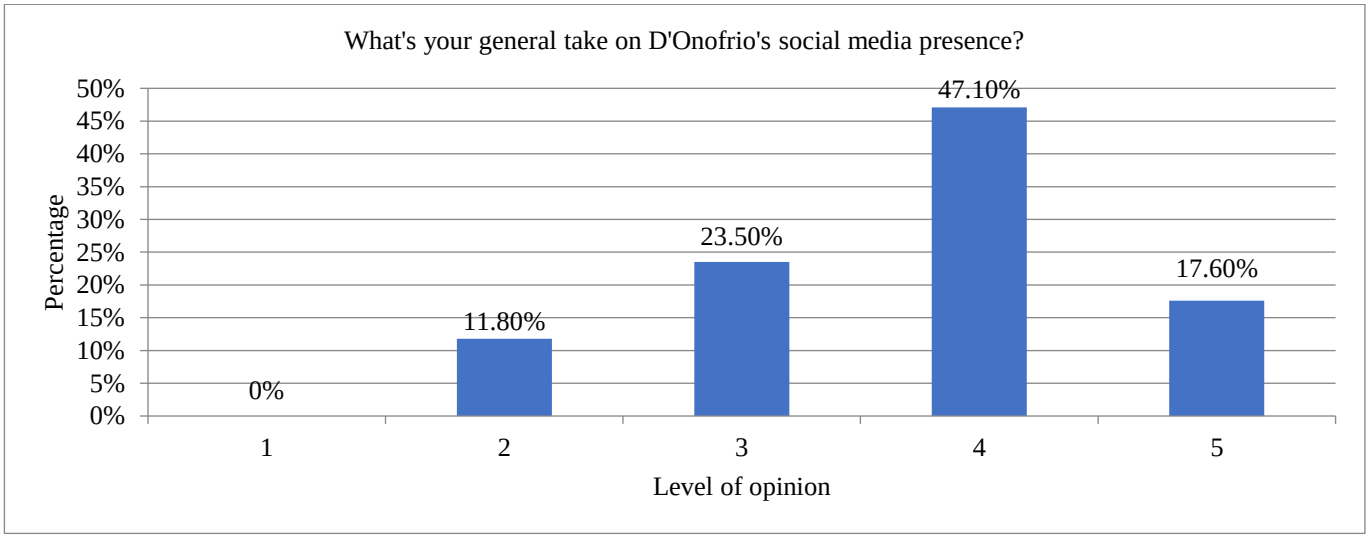

Fig. 11 Level of opinion

Therefore, to present the data collected, the most relevant information for this research will be shown. This will provide a clear and concise view of the results obtained.

Figure 9 shows the results obtained in response to the question, "How much time do you spend on social networks every day?" where 35% of respondents answered that they spend more than 3 hours a day on social networks, which indicates that there is a considerable amount of time dedicated to social network activity.

On the other hand, Figure 10 shows the results obtained in response to the question, "What are the main social networks you use? 64% of the respondents use Facebook as their main social network, followed by Instagram with 52% and Twitter with 41%. These data indicate the most popular social networks among respondents.

Also, Figure 11 shows the results of the question, "What is your general opinion about D'Onofrio's presence in social networks? 47% of the respondents answered at level 4 out of 5, indicating they were very satisfied. These results reflect a positive perception of the company's presence on digital platforms.

On the other hand, Figure 12 shows the results of the question: Do you think the use of sentiment analysis in social networks can help D'Onofrio better understand the needs and opinions of its customers? It is observed that 70.6% of the respondents answered affirmatively, indicating that it would be very favorable to use sentiment analysis to understand the demands and perceptions of D'Onofrio's customers. Therefore, these results highlight the importance and potential benefit perceived in using this technique for the company.

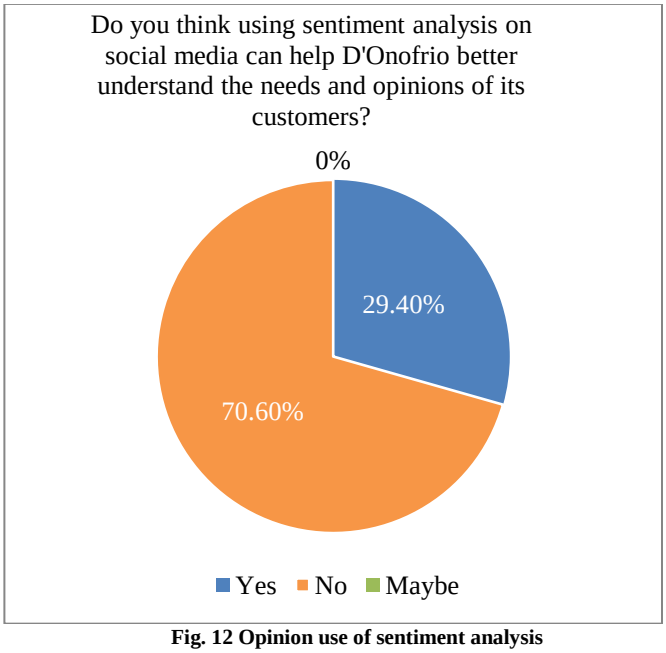

Fig. 12 Opinion use of sentiment analysis

Finally, with respect to the question "What is your general opinion about D'Onofrio's presence in social networks?" where the most outstanding answers obtained were that it should be more descriptive and friendly, they also indicated that the proposal is innovative, as it would be very useful to be able to validate the comments of certain products.

However, negative opinions, such as the lack of information and very abstract design, were also obtained.

Based on the results obtained in the question about the time of activity on social networks, where it is observed that 35% of respondents spend more than 3 hours a day on social networks, and in the question about the general opinion of D'Onofrio's presence on social networks, where 47% of respondents answered very satisfactorily, it can be concluded that there is a high potential for user interaction with the brand on digital platforms.

On the other hand, the results of the question on the main social networks used by respondents, where it is highlighted that 64% use Facebook as the main social network, followed by Instagram (52%) and Twitter (41%), indicate that these platforms are key channels to reach D'Onofrio's consumers. This data supports the need to implement effective marketing strategies in these social networks to maximize reach and customer interaction.

Likewise, the results of the question on whether the use of sentiment analysis in social networks can help D'Onofrio to understand better the needs and opinions of its customers, where 70% of respondents answered favorably, reinforce the importance of implementing sentiment analysis techniques in the different marketing strategies of the organization.

The comments obtained in response to the question about the general opinion of D'Onofrio's social media presence, where positive aspects such as innovation and usefulness of the proposal were mentioned, as well as negative aspects such as lack of information and abstract design, are indicative of the areas in which the company can strengthen its social media presence strategy.

Overall, the survey results indicate a significant opportunity for D'Onofrio in the context of social media platforms and sentiment research. These findings support implementing a web-based system with machine learning for social media sentiment analysis. This can help the company better understand its customer's needs and opinions, strengthen its relationship with them, and improve its online marketing strategies.

However, it is also important to address the aspects pointed out as areas for improvement by users, such as lack of information and abstract design, to ensure an effective and satisfactory presence in social networks.

5. Conclusion

In conclusion, this study has focused on the implementation of a web system with machine learning to perform sentiment analysis techniques in one of the social media platforms in the marketing context of the company D'Onofrio to identify in the comments, the opinions and needs of consumers, so that the company can improve the effectiveness of marketing strategies. Throughout the research, the importance of this approach in the current situation of social media platforms and its relevance for companies seeking to improve their relationship with customers has been demonstrated.

The findings of this study show that the analysis of emotions or feelings in social networks can provide valuable information about the opinions and emotions of users or consumers towards D'Onofrio's products and services. The application of natural language processing and machine learning methods has made it possible to identify and classify the sentiments expressed by users, which provides a deeper understanding of brand perceptions.

The use of the DMAIC methodology, together with the combined Kanban methodology, has facilitated the monitoring and control of the web system implementation process. Using a Kanban board has improved the visibility and efficiency of the workflow, allowing for more effective task management and resource allocation.

The practical implications of this study are significant for D'Onofrio and the food industry in general. By understanding consumers' opinions and needs through social media sentiment analysis, D'Onofrio will be able to adjust its marketing strategies and achieve effective improvement in customer satisfaction. In addition, by strengthening customer relationships and demonstrating genuine engagement, D'Onofrio will be able to build a positive brand image and increase its market positioning.

While this study has provided valuable information, it is important to keep in mind its limitations. Sentiment analysis in social networks has certain inherent limitations, such as difficulty correctly interpreting the context and the need for constant adjustment and updating of analysis models. In addition, this study has focused specifically on the Spanish language and user perceptions of social network platforms, which may pose a limitation in the generalizability of the results.

In future research, it is recommended to investigate the implementation of aspect-based sentiment analysis techniques to understand better users' opinions on specific features of D'Onofrio's products. Also, it would be interesting to expand the study to other languages and social media platforms with the purpose of acquiring a more comprehensive view of consumer perceptions.

To conclude, this study has evidenced the effectiveness of sentiment analysis in social networks as an effective tool to increase the effectiveness of decision-making within D'Onofrio's marketing scope. By understanding and properly utilizing consumer opinions and emotions, D'Onofrio will be in a favorable position to adapt to market needs, strengthen its relationship with customers and improve its competitiveness in the food industry.

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