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Sentiment Analysis Using Fuzzy Logic on Medan Culinary Tourism Based on Google Maps User Reviews About Lontong Kak Lin

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Abstract

In the digital era, user reviews on platforms like Google Maps play a crucial role in assessing the quality of culinary destinations. Lontong Kak Lin, a well-known culinary spot in Medan, has received numerous customer reviews. This study aims to analyze user sentiment towards Lontong Kak Lin using the fuzzy logic method. The research methodology includes collecting user reviews from Google Maps, preprocessing the text by cleaning data, tokenization, and removing stopwords, followed by applying fuzzy logic to classify sentiments into positive, neutral, and negative categories. Sentiment analysis is conducted using the Fuzzy Inference System (FIS), integrating the VADER and TextBlob algorithms to handle subjectivity in reviews. The study results show that out of 994 collected reviews, 697 reviews (70%) were classified as positive, 130 (13%) as negative, and 167 (16%) as neutral. The developed model achieved an accuracy rate of 66%, with precision of 80% for the positive class, 49% for the negative class, and 21% for the neutral class. These findings suggest that combining FIS with TextBlob and VADER can effectively analyze sentiment in textual data. This research aims to provide valuable insights for culinary business owners to improve service quality based on customer feedback.

Keywords: *Sentiment Analysis, Fuzzy Logic, Google Maps, Fuzzy Inference System*

1. Introduction

The internet has become an important tool in accessing information and communication in today's digital era. Indonesia, with a very large number of internet users, has experienced a significant increase in online activities to share opinions. From the results of the 2024 Indonesian internet penetration survey released by APJII, Indonesia's internet penetration rate reached 79.5% (APJJ, 2024).

Google Maps is an internet-based platform that provides digital mapping services to help users find locations and obtain various information related to a place. In the business world, Google Maps has a strategic role, especially as a marketing and communication tool. Its use in the culinary industry, as studied in the context of the culinary business in Surabaya [5] [7], shows that Google Maps is not only an effective navigation tool and promotional media, Google Maps also functions as an interaction platform between customers and business owners through review and rating features. Consumers can provide opinions about their experiences, which can then be a reference for other customers in making decisions. Thus, Google Maps contributes to increasing business visibility and building business reputation in the digital era.

Indonesia is a country rich in cultural heritage and natural beauty, and one of the most captivating aspects of this cultural richness is culinary tourism. Established since 1985, Lontong Kak Lin has become one of the city's famous culinary icons. People can easily give their opinions and responses to a place. Comments and ratings directed at certain culinary destinations, such as Lontong Kak Lin, often contain positive, neutral, and negative sentiments.

Although several previous studies have applied sentiment analysis with various machine learning approaches such as decision tree algorithms [1] and fuzzy logic [6] [2] in various sectors, research that specifically highlights culinary reviews on Google Maps using the fuzzy logic method is still limited. Thus, this study is expected to fill this gap and provide useful insights for culinary business actors in understanding and responding to customer perceptions more appropriately. This study aims to evaluate the effectiveness of fuzzy logic in analyzing Google Maps user review sentiment and providing strategic recommendations based on the results of the analysis.

2. Research Method

This research consists of several processes as illustrated in Figure 1.

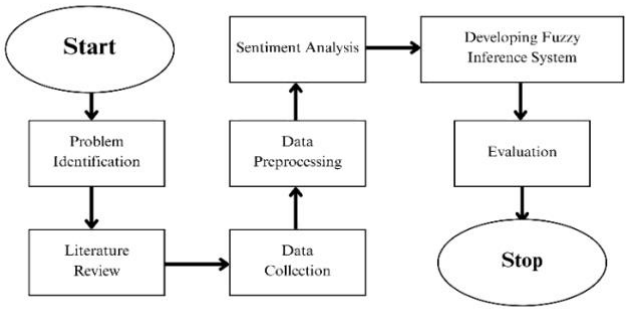


Fig. 1: Research Workflow

2.1. Problem Identification

Researchers in this stage will identify and define the topic to be analyzed. The topic chosen for analysis is sentiment on Google Maps user reviews on Lontong Kak Lin.

2.2. Literature Review

Literature review is a step to find theoretical foundations that support problem-solving.The literature required in this study includes journals and books related to sentiment analysis and fuzzy logic.

2.3. Data Collection

At this stage, the researcher collects the data to be analyzed.In this study, the data collected consists of user reviews about Lontong Kak Lin found on Google Maps. The review data was obtained using an API provided by RapidAPI.

2.4. Data Preprocessing

Researchers will clean the data before analyzing it. Data preprocessing is needed so that the analysis can run optimally. Data preprocessing includes: (1) Removing punctuation and emojis; (2) Case Folding, changing all uppercase letters to lowercase letters; (3) Tokenization, breaking sentences into words; (4) Stop word removal, removing common words that are not significant in the text; (5) Lemmatization, changing words back to their basic form.

2.5. Sentiment Analysis

After the data is cleaned, the researcher will conduct sentiment analysis on the data. The researcher will use TextBlob and Vader on the data which will produce a polarity score value between -1 (negative) to 1 (positive).

2.6. Developing Fuzzy Inference System

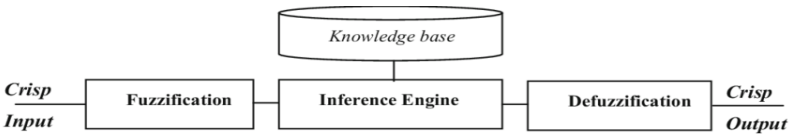


Fig. 2: Fuzzy Inference System

Fuzzy Inference System (FIS) is a system that uses fuzzy logic to map input to output based on fuzzy rules. Researchers in this stage will develop FIS with the following stages: (1) Defining linguistic variables; (2) Determining fuzzy sets; (3) Determining the application of the implication function; (4) Determining the composition of the rules; (5) Determining the defuzzification method (affirmation).

2.7. Evaluation

Evaluation is done to see the accuracy of the system by comparing the output results from FIS with test data. In this case, the test data has a rating given by the user will be compared with the output results from FIS.

Tab 1: Relationship Between Sentiment and Rating

Sentiment	Rating
Positive	[1,2]
Neutral	3
Negative	[4,5]

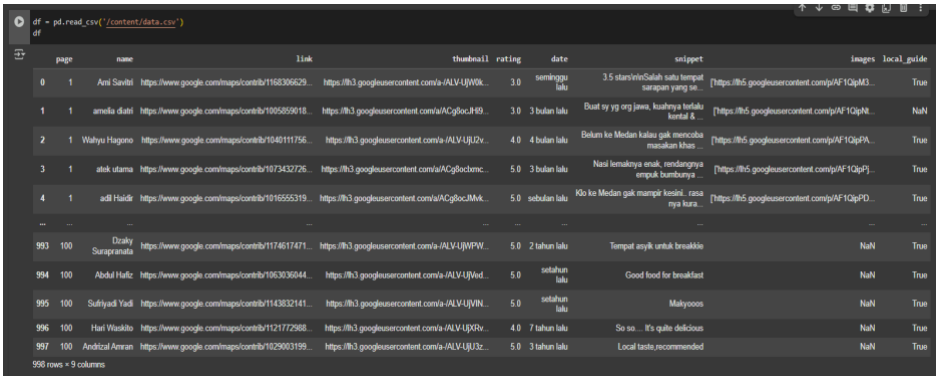
In this case, researchers use accuracy, precision, recall and F1-Score metrics. Accuracy measures the extent to which sentiment analysis matches the overall test data. Precision indicates the proportion of correct positive predictions compared to the total positive predictions generated by the system. Recall measures the extent to which the model can detect all positive instances in the test data. F1-Score is the harmonic mean of precision and recall, which is used to balance the two, especially if there is an imbalance in sentiment data.With this evaluation, it is expected to determine the extent to which the system is effective in performing fuzzy logic-based sentiment analysis on user reviews on Google Maps regarding Lontong Kak Lin."

3. Result and Discussion

All paragraphs must be justified alignment. With justified alignment, both sides of the paragraph are straight.

3.1. Data Collection

Data collection is done using the Google Maps API provided by RapidAPI. Raw data from the API that has been successfully collected. The collected data is 998 rows with 9 columns that look like the image below.



```
df = pd.read_csv('/content/data.csv')
df
```

	page	name	link	thumbnail	rating	date	snippet	images	local_guide
0	1	Ami Savitri	https://www.google.com/maps/contrib/116830662...	https://lh3.googleusercontent.com/a-/ALV-UjW0k...	3.0	seminggu lalu	3.5 stars\n\nSalah satu tempat sarapan yang se...	[https://lh5.googleusercontent.com/p/AF1QipM3...	True
1	1	amelia diahl	https://www.google.com/maps/contrib/100585901 8...	https://lh3.googleusercontent.com/a/ACg8ocJH9...	3.0	3 bulan lalu	Buat sy yg org jawa, kuahnya terlalu kental & ...	[https://lh5.googleusercontent.com/p/AF1QipNt...	NaN
2	1	Wahyu Hagono	https://www.google.com/maps/contrib/1040111756...	https://lh3.googleusercontent.com/a-/ALV-UjUZv...	4.0	4 bulan lalu	Belum ke Medan kalau gak mencoba masakan khas ...	[https://lh5.googleusercontent.com/p/AF1QipPA...	True
3	1	atek utama	https://www.google.com/maps/contrib/1073432726...	https://lh3.googleusercontent.com/a/ACg8ocbxmc...	5.0	3 bulan lalu	Nasi lemaknya enak, rendangnya empuk bumbunya ...	[https://lh5.googleusercontent.com/p/AF1QipPj...	True
4	1	adil Haidir	https://www.google.com/maps/contrib/1016555319...	https://lh3.googleusercontent.com/a/ACg8ocJMvk...	5.0	sebulan lalu	Klo ke Medan gak mampir kesini.. rasa nya kura...	[https://lh5.googleusercontent.com/p/AF1QipPD...	True
...	...	...	...	...	...	...	...	...	...
993	100	Dzaky Suraprianata	https://www.google.com/maps/contrib/1174617471...	https://lh3.googleusercontent.com/a-/ALV-UjWPW...	5.0	2 tahun lalu	Tempat asyik untuk breakkie	NaN	True
994	100	Abdul Hafiz	https://www.google.com/maps/contrib/1063036044...	https://lh3.googleusercontent.com/a-/ALV-UjVed...	5.0	setahun lalu	Good food for breakfast	NaN	True
995	100	Sufriyadi Yadi	https://www.google.com/maps/contrib/1143832141...	https://lh3.googleusercontent.com/a-/ALV-UjVIN...	5.0	setahun lalu	Makyooos	NaN	True
996	100	Hari Wasikito	https://www.google.com/maps/contrib/1121772988...	https://lh3.googleusercontent.com/a-/ALV-UjXRv...	4.0	7 tahun lalu	So so.... It's quite delicious	NaN	True
997	100	Andrizal Amran	https://www.google.com/maps/contrib/1029003199...	https://lh3.googleusercontent.com/a-/ALV-UjU3z...	5.0	3 tahun lalu	Local taste,recommended	NaN	True

998 rows × 9 columns

Fig. 3: Raw API Data

Since this research is a sentiment analysis research, the researcher only uses the required columns, namely ratings and snippets. Sample data can be found in Table 2 below.

Tab. 2: Example of Filtered Data.

Rating	Review
3	Rasanya seperti lontong sayur pd umumnya.
3	Buat sy yg org jawa, kuahnya terlalu kental & pedes, apalagi kl utk sarapan pagi. Komplit sih sebenernya condiment nya ada : soun, kering kentang & tempe, kc panjang. Sy pake tambahan rendang & telor. Sayang krupuk pink ala padangnya cuka dikasih dikit. Sy beli pulut juga, lumayan lah rasanya. Variasi makanannya lumayan ada : nasi lemak, nasi gurih, lupis, roti dll Ada gorengannya juga: bakwan, tahu, risol, kue sus Tlg kebersihan ditingkatkan
3	ada dua pilihan menu, pake lontong atau pake nasi. yang pake nasi enak, nasinya kaya nasi uduk gitu, terus lauknya banyak. yang pake lontong, review dari temen katanya juga enak dan kalo balik ke medan pengen balik kesini lagi. ada sate sateannya juga. tempatnya cukup luas, harganya juga murah. mantaaabs 😋👍😋👍😋👍

3.2. Data Preprocessing

After the data is successfully collected, the next step is to pre-process the data. The first stage in preprocessing is translation. The review ex is first translated into English. In this case, the researcher uses the Translator library (which uses Google Translate). This is because Google Translate is able to translate formal and informal standard words into English. An example of a translation can be seen in Table 3.

Tab. 3: Translation Examples

Rating	Review	Translate
3	Rasanya seperti lontong sayur pd umumnya.	It tastes like vegetable lontong in general.
3	Buat sy yg org jawa, kuahnya terlalu kental & pedes, apalagi kl utk sarapan pagi…...	For me, a Javanese person, the sauce is too thick & spicy, especially for breakfast….
3	ada dua pilihan menu, pake lontong atau pake nasi. yang pake nasi enak, nasinya kaya nasi uduk gitu, terus lauknya banyak….	There are two menu choices, using lontong or using rice. the one with rice is delicious, the rice is like uduk rice, and there are lots of side dishes. ….

After being translated, the next step is text cleaning and case folding. Text-cleaning and case-folding are two important steps in text data processing, especially in the field of Natural Language Processing (NLP). Text-cleaning refers to the process of cleaning text data from elements that are irrelevant or potentially disruptive to analysis, such as punctuation, numbers, special symbols, or unwanted characters. Case-folding is the process of converting all letters in the text to lowercase. This aims to equalize the text format, so that the same words with different capital letters ("Data" and "data") are treated as the same entity. These two steps aim to simplify and align text data so that it is easier to analyze or process in the next stage. The library used is "clean-text". An example of processing can be seen in Table 4.

Tab. 4: Examples of Text Cleaning and Case Folding Processing

Rating	Translate	Cleaning Results
3	It tastes like vegetable lontong in general.	it tastes like vegetable lontong in general
3	For me, a Javanese person, the sauce is too thick & spicy, especially for breakfast….	for me a javanese person the sauce is too thick spicy especially for breakfast its actually complete the condiments are vermicelli dry potatoes tempeh long beans i added rendang egg unfortunately the padang style pink crackers were given a little vinegar i bought pulut too it tastes good there is quite a variety of food nasi lemak savory rice lupis bread etc there are fried foods too bakwan tofu risol eclairs please improve cleanliness
3	There are two menu choices, using lontong or using rice. the one with rice is delicious, the rice is like uduk rice, and there are lots of side dishes. ….	there are two menu choices using lontong or using rice the one with rice is delicious the rice is like uduk rice and there are lots of side dishes those who use lontong reviews from friends say its also delicious and if i go back to medan i want to come back here again theres satay satay too the place is quite spacious the price is also cheap mantaabs

After the text is cleaned and case folding is applied, the next step is stopwords removal. Stopwords removal is the process of removing common words (known as stopwords) from text data to improve the efficiency and accuracy of text analysis. Stopwords are words that occur frequently in a language but usually do not have significant information value or contribute to understanding the context, such as "dan", "di", "ke", "yang" in Indonesian, or "and", "the", "in", "on" in English. An example of processing can be seen in Table 5.

Tab 5: Stopwords Removal Example

Rating	Cleaning Results	Stopwords Removal Results
3	it tastes like vegetable lontong in general	tastes like vegetable lontong general
3	for me a javanese person the sauce is too thick spicy especially for breakfast its actually complete the condiments are vermicelli dry potatoes tempeh long beans i added rendang egg unfortunately the padang style pink crackers were given a little vinegar i bought pulut too it tastes ….	javanese person sauce thick spicy especially breakfast actually complete condiments vermicelli dry potatoes tempeh long beans added rendang egg unfortunately padang style pink crackers given little vinegar bought pulut tastes good quite variety food nasi lemak savory rice lupis bread etc fried foods bakwan tofu risol eclairs please improve cleanliness
3	there are two menu choices using lontong or using rice the one with rice is delicious the rice is like uduk rice and there are lots of side dishes those who use lontong reviews from friends say its also delicious …..	two menu choices using lontong using rice one rice delicious rice like uduk rice lots side dishes use lontong reviews friends say also delicious go back medan want come back theres satay satay place quite spacious price also cheap mantaabs

Then, the next stage is lemmatization. Lemmatization is a process in Natural Language Processing to change words in text to basic forms or lemmas that are in accordance with the grammatical context. Unlike stemming which only removes affixes without considering the validity of the word, lemmatization considers the morphological structure and meaning of the word to produce a basic form that is in accordance with the rules of the language used. The purpose of lemmatization is to increase accuracy in text analysis by equating variations of words that have similar meanings into one correct lemma form. An example of delivery can be seen in Table 6.

Tab 6: Lemmatization Example

Rating	Stopwords Removal Results	Lemmatization Results
3	tastes like vegetable lontong general	taste like vegetable lontong general
3	javanese person sauce thick spicy especially breakfast actually complete condiments vermicelli dry potatoes tempeh long beans added rendang egg unfortunately padang style pink crackers given little vinegar bought pulut tastes good quite variety food nasi lemak savory rice lupis bread etc fried foods bakwan tofu risol eclairs please improve cleanliness	javanese person sauce thick spicy especially breakfast actually complete condiment vermicelli dry potato tempeh long bean add rendang egg unfortunately padang style pink cracker give little vinegar buy pulut taste good quite variety food nasi lemak savory rice lupis bread etc fry food bakwan tofu risol eclair please improve cleanliness
3	two menu choices using lontong using rice one rice delicious rice like uduk rice lots side dishes use lontong reviews friends say also delicious go back medan want come back theres satay satay place quite spacious price also cheap mantaabs	two menu choice use lontong use rice one rice delicious rice like uduk rice lot side dish use lontong review friend say also delicious go back medan want come back there s satay satay place quite spacious price also cheap mantaabs

3.3. Sentiment Analysis

TextBlob utilizes a dataset called "Pattern Lexicon" to determine the polarity value of each word. This dataset consists of a list of words along with their respective polarity values. The polarity assessment process is carried out by adding up the polarity values of each word contained in a sentence. For each sentence in the text, TextBlob will generate a polarity score in the range of -1 to 1, where -1 represents a very negative sentiment, 0 indicates a neutral sentiment, and 1 describes a very positive sentiment.

VADER (Valence Aware Dictionary and Sentiment Reasoner) is a lexicon-based sentiment analysis method specifically designed to handle everyday language texts, including reviews, social media, and informal comments. VADER utilizes a dictionary of words that have been given a sentiment score based on their emotional valence. Each word in the VADER dictionary has a sentiment value ranging from -1 to 1. A value of -1 indicates a very negative sentiment, 0 means neutral, and 1 represents a very positive sentiment. An example of the results of the sentiment calculation can be seen in Table 7.

Tab 7: Example of Sentiment Analysis Results

Rating	Stemmed	Vader	Textblob
3	taste like vegetable lontong general	0.3612	0.05
3	javanese person sauce thick spicy especially breakfast actually complete condiment vermicelli dry potato tempeh long bean add rendang egg unfortunately padang style pink cracker give little vinegar buy pulut taste good quite variety food nasi lemak savory rice lupis bread etc fry food bakwan tofu risol eclair please improve cleanliness	0.6908	-0.044907407
3	two menu choice use lontong use rice one rice delicious rice like uduk rice lot side dish use lontong review friend say also delicious go back medan want come back there s satay satay place quite spacious price also cheap mantaabs	0.9231	0.48

3.4. Developing Fuzzy Inference System (FIS)

The following table shows the variables used along with the universe of discussion used in this study.

Tab 8: Variables and The Universe of Conversation

Variables	Universe of Conversation
Vader Polarity	[-1, 1]
TextBlob Polarity	[-1, 1]
Sentiment Results	[-1, 1]

In this study, there are three main variables used in the fuzzy inference system, namely VADER Polarity, TextBlob Polarity, and Sentiment Results. These three variables have the same universe of discussion and are each defined into three fuzzy categories, namely Negative, Neutral, and Positive. As in the table below.

Tab 9: Determination of Variables and Universe of Discussion

Fuzzy Set	Value
Negative	[-1, 0]
Neutral	[-0.5, 0.5]
Positive	[0, 1]

Since the three variables, namely VADER Polarity, Textblob Polarity, and Sentiment Results, have identical fuzzy boundaries and categories, the graphical representation of their membership functions is also similar. The representation of these membership functions is shown in Figure 4.

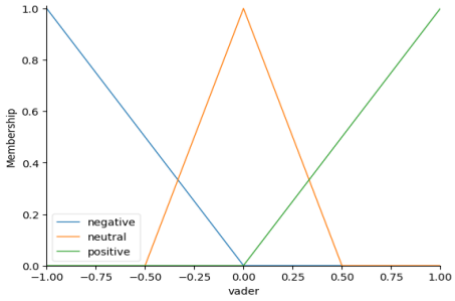


Fig. 4: Variable Representation

The membership functions of the three variables are:

$$\mu Negative\left[X_{1,2,3}, Y\right] = \begin{cases} 1; & x \leq -1 \\ -x; & -1 < x < 0 \\ 0; & x \geq 0 \end{cases}$$

$$\mu Neutral\left[X_{1,2}, Y\right] = \begin{cases} 0; & x \leq -0.5 \\ \dfrac{x + 0.5}{0.5}; & -0.5 < x < 0 \\ 1 - \dfrac{x}{0.5}; & 0 \leq x < 0.5 \\ 0; & x \geq 1 \end{cases}$$

$$\mu Positive\left[X_{1,2}, Y\right] = \begin{cases} 0\,; & x \leq 0 \\ x\,; & 0 < x < 1 \\ 1\,; & x \geq 1 \end{cases}$$

Where X_1 is VADER polarity, X_2 is TextBlob polarity, and Y is Sentiment Results.

At this stage, the author creates fuzzy logic rules based on the existing data after determining the membership function for each variable. Based on the fuzzy inference system reasoning unit in the form:

"If x is A and y is B, then z is C"

If x is associated with the VADER polarity result variable and A is its linguistic value, y is associated with the TextBlob polarity result variable and B is its linguistic value, and z is associated with the Sentiment Result and C is its linguistic value, then the rules presented in the table are formed. The implication function used is the MIN rule.

Tab. 10: Fuzzy Rule

Rules	Vader (X_1)	TextBlob(X_2)	Sentiment Result (Y)
R1	Positive	Positive	Positive
R2	Positive	Neutral	Positive
R3	Positive	Negative	Neutral
R4	Neutral	Positive	Positive
R5	Neutral	Neutral	Neutral
R6	Neutral	Negative	Negative
R7	Negative	Positive	Neutral
R8	Negative	Neutral	Negative
R9	Negative	Negative	Negative

After all the rules are processed, the rule composition will be performed. This process combines all fuzzy outputs from the rules that have been processed into one combined fuzzy output. This study uses the MAX method to take the highest value from the calculated rules. After the rule composition is complete, the fuzzy output results (in the form of fuzzy membership functions) are converted into crisp values using the defuzzification method. This study uses the centroid method defuzzification. The classification used to change the output results into positive, negative and neutral classes can be seen in Table 11 below.

Tab. 11: Sentiment Class Classification

Output Deffuzifikasi	Sentiment Class
R1	Positive
R2	Positive
R3	Positive

Tab. 12: Defuzzifikasi Output

Rating	Hasil Lematisasi	VADER	TextBlob	Output Deffuzifikasi	Hasil Sentimen
3	taste like vegetable lontong general	0.3612	0.05	0.331012113	*positive*
3	javanese person sauce thick spicy especially breakfast actually complete condiment vermicelli dry potato tempeh long bean add rendang egg unfortunately padang style pink cracker give little vinegar buy pulut taste good quite variety food nasi lemak savory rice lupis bread etc fry food bakwan tofu risol eclair please improve cleanliness	0.6908	-0.044907407	0.598597834	*positive*
3	two menu choice use lontong use rice one rice delicious rice like uduk rice lot side dish use lontong review friend say also delicious go back medan want come back there s satay satay place quite spacious price also cheap mantaabs	0.9231	0.48	0.607368421	*positive*

3.5. Evaluation

By calculating the rating according to Table 1, 697 positive, 130 negative and 167 neutral were obtained. The classification performance of Fuzzy Inference System (FIS) with VADER and TextBlob can be seen in Table 13.

Tab. 13: Classification Report

	Precision	Recall	F1-Score	Support
Negative	0.49	0.51	0.50	130
Neutral	0.21	0.20	0.21	167
Positive	0.80	0.80	0.80	697
Accuracy			0.66	994
Macro Avg	0.50	0.50	0.50	994
Weighted Avg	0.66	0.66	0.66	994

From the table, it can be seen that the positive class has the best performance with precision, recall, and F1-score of 0.80 each, indicating that FIS is able to identify and predict the positive class well. In contrast, the negative class has a lower score with an F1-score of 0.50, while the neutral class has the weakest performance with an F1-score of only 0.21, indicating the model's difficulty in handling neutral data. Overall, the model's accuracy reaches 66%, with a macro average F1-score of 0.50, indicating an imbalance in performance between classes. The weighted average, which is also 0.66, confirms that the class with the larger amount of data (positive) dominates the classification results.

4. Conclusion

Based on the results of the research that has been conducted, sentiment analysis of culinary tourism in Medan City, especially on the Lontong Kak Lin object, has been successfully implemented using the fuzzy logic method. The research process starts from data collection, followed by data preprocessing stages in the form of translation, text cleaning, case folding, stopword removal, and lemmatization, to the implementation of the fuzzy inference system (Fuzzy Inference System/FIS). The evaluation results show that the system built has an accuracy rate of 66%, with a precision value of 80% for the positive class, 49% for the negative class, and 21% for the neutral class. This shows that the FIS method that combines analysis from TextBlob and VADER can be a fairly effective approach in conducting sentiment

analysis on user review texts. From a total of 994 data analyzed, 697 reviews (70%) were positive sentiment, 130 reviews (13%) were negative sentiment, and 167 reviews (16%) were neutral. Thus, it can be concluded that the majority of customers have a positive impression of Lontong Kak Lin based on their reviews on Google Maps.

Acknowledgement

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