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SENTIMENT ANALYSIS OF TOURIST REVIEWS ON ECOTOURISM CLUSTERS IN MALAYSIA FOR SUSTAINABLE DEVELOPMENT

IDA FARINA MUHD YUNUS[1*], ROSITA HUSAIN[2], ROHAIZA MOHAMAD IDARIS[3]

[1, 2,3] Faculty of Business and Accountancy, University of Selangor, Malaysia

*Corresponding Author: ida_na@unisel.edu.my

Abstract: Ecotourism is essential for sustainable tourism as it aims to protect natural and cultural resources while offering tourists unique experiences. This paper utilised sentiment analysis of online reviews to determine how tourists feel about Malaysia's ecotourism destinations. The methodology involved collecting and analysing reviews using natural language processing (NLP) techniques. An online platform TripAdvisor was used for data collection. This study analysed customer reviews from 2018 to 2024 and revealed customer satisfaction towards tourism destinations. The sentiment analysis was categorised into positive, negative, and neutral, and afterwards, the reviews from six detailed ecotourism clusters were further analysed. Based on the sentiment analysis, most sentiments in every cluster are positive, even though the polarity amounts and subjectivity vary. The key themes identified include nature, service, culture, adventure, and relaxation, highlighting the diverse attractions ranges that draw tourists to these destinations. Additionally, the study identifies places that may need improvement, particularly in groups with higher numbers of neutral or negative feelings. Several recommendations were made, including investing in infrastructure, improving visitor services, monitoring ongoing feedback, getting local communities involved, and effectively marketing destinations. The result assists in understanding how tourists feel and offers useful information for improving the sustainability of ecotourism places in Malaysia while ensuring visitor satisfaction and contentment.

Keywords: Ecotourism, Sustainable tourism, Online reviews, Sentiment analysis, Visitor experience

1. Introduction

Ecotourism is viewed as preserving and conserving the world's diverse natural and cultural resources. It involves traveling to untouched natural areas in an environmentally responsible way to appreciate and enjoy nature (Hussain, 2022). As a part of sustainable tourism, ecotourism offers visitors a distinct experience, supporting local community well-being, protecting natural resources, preserving local culture, and ensuring a harmonious balance between tourists and the community. It fosters regional growth by utilising natural resources and incorporating natural landscapes, and biodiversity into tourism (Stanciu et al., 2022). In Malaysia, the demand for ecotourism activities has been increasing, aligning with

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the National Tourism Policy 2020-2020, which aims to position the country among the world's top ten tourism destinations. This policy emphasises sustainability as a core principle (Ministry of Tourism, Art and Culture [MOTAC], 2020). This can be done through fostering partnerships, sharing expertise and experience, and enhancing the skills and potential of the local community. According to the World Travel & Tourism Council's [WTTC] (2024) Economic Impact Research, Malaysia's travel and tourism sector is expected to increase significantly in 2024, with MYR198.7 BN expected, representing 10.5 percent of the nation's GDP and 1.9 percent higher than 2019. This growth highlights the potential for ecotourism to strengthen the economy, boost local business, and encourage ecosystem and wildlife conservation, creating a sustainable environment that supports both the community and the wider tourism sector (Malaysian Investment Development Authority [MIDA], 2024).

However, Malaysia faces unique challenges in balancing environmental conservation with economic benefits. Effective ecotourism management is crucial for sustainable development, but its success depends on rigorous planning, regulation, and continuous evaluation (Prakash Seervi, 2023). The field of eco-tourism research has rapidly expanded, evolving through three distinct phases: 1- human disturbance, 2- ecosystem services, and 3- sustainable development (Han et al., 2022). The key challenges include ensuring that the initiative contributes to sustainability rather than merely exploiting the "eco" label for commercial gain. Striking a balance between environmental conservation and economic benefits is a major concern.

The importance of sentiment analysis in ecotourism is vital but not fully utilised in Malaysia. Existing studies use various data sources and machine learning for sentiment classification however, gaps remain in integrating feedback with sustainable development (Nor Hasliza Md Saad & Zulnaidi Yaacob, 2021; Lingling et al., 2022). Therefore, this study aims to assess tourist sentiment towards ecotourism places in Malaysia by analysing online reviews. The research offers recommendations for sustainable development by identifying prominent attributes and identifying the emotional tone of tourist experiences, and feelings to highlight areas for improvement. By focusing on Malaysia-specific challenges and opportunities, this study seeks to bridge the gap between background information and research focus, providing actionable insights for the sustainable growth of ecotourism in the country (Fennell, 2020; Shaha et al., 2020).

2. Research Problem

The challenges of the study lie in the gap between the growing importance of ecotourism in Malaysia and the limited understanding of tourist attitudes and experiences. Ecotourism aims to protect the environment while giving tourists unique experiences. However, the typical mechanism of getting feedback through survey questionnaires did not always capture tourists' real feelings. Current research has not adequately utilised tourists' comments and reviews via online platforms to integrate the feedback into sustainable development initiatives. Therefore, sentiment analysis was proposed to incorporate tourist feedback into sustainable development strategies. Baosheng et al. (2020) use online reviews to measure tourists' satisfaction with wetland ecotourism, revealing methodological hurdles.

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In addition, the criteria for assessing ecotourism sustainability can be applied to similar destinations. Studies using strength, weakness, opportunities, threat (SWOT) and driver, pressure, state, impact, response (DPSIR) frameworks, and sustainable development strategies in various locations highlight the need for strategic planning and adherence to sustainable practices (Fallah & Ocampo, 2020; Swangjang & Kornpiphat, 2021). These studies demonstrate the potential of advanced analysis methods to promote ecotourism, but a comprehensive application that integrates sentiment analysis with sustainable development is still missing. In this regard, this study aims to uncover important issues and areas for improvement by evaluating tourists' feedback and reviews in different ecotourism clusters through sentiment analysis. The outcome will ultimately improve visitor satisfaction and the sustainability of Malaysian eco-tourism by providing stakeholders with useful information to make decisions on marketing, community involvement, infrastructure, and services.

3. Literature Review

3.1 Ecotourism in Malaysia

Malaysia is divided into two major regions separated by the South China Sea; Peninsular Malaysia in the west, and East Malaysia in the east. The country is surrounded by numerous smaller islands and is rich in natural, and heritage attractions. Due to the existence of mountain ranges in Peninsular Malaysia such as Banjaran Titiwangsa and several mountain ranges in East Malaysia such as Banjaran Crocker, Banjaran Trusmadi, and Banjaran Tama Abu, the climate of the area is classified into highland, lowland, and coastal regions. These privileges allow for various ecotourism options including jungle explorations, island hopping, mountain trekking, river cruising, wildlife watching, discovering flora and fauna, flora, fauna, and fishing. The distinctive uniqueness of the highlands including their natural beauty, historical heritage, moderate climate, and habitat for diverse flora and fauna are the main reasons for their popularity as tourist destinations (Ibrahim & Yusnita Yusof, 2017). Moreover, Fennell (2020) stated that ecotourism is successful in various environments and diverse habitats that offer unique and unforgettable experiences.

Following Malaysia's National Ecotourism Plan which highlighted ecotourism as one of the primary factors for economic development, the recognition and accreditation of several areas including Kinabalu Park in Sabah, Niah National Park, and Gunung Mulu National Park in Sarawak, and Langkawi Island as Unesco Heritage Site and Unesco Global Geoparks, could directly attract more tourists to the nation (Tourism Malaysia, 2023). Over the years, there has been a lot of discussion regarding the potential ecotourism in Malaysia, but the situation is more complicated than it seems, as summarised by Asqarbek et al. (2023): there is a lack of support from the government and local administration, inadequate infrastructure, the local population has little awareness about the application of ecotourism, and there is a shortage of scientist in the ecology field. However, Velan Kunjuraman (2024), suggests that major players exerting pressure on the state tourism department should be encouraged to facilitate and promote ecotourism in the country which might achieve its goals. Engagement of this type is important for the continuity of ecotourism projects.

Figure 1 shows the proposed ecotourism cluster areas. Sustainable resources used through recreation and tourism are outlined in the country's biodiversity policy, highlighting

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the increased importance of fostering conservation attitudes. The Ministry of Tourism and Culture Malaysia (MOTAC) has introduced the concept of clustering in eco-tourism as a part of the National Ecotourism Plan 2016-2025 to leverage economies of scale in various areas such as infrastructure development, marketing and promotion, manpower and human resources, product development, and destination management.

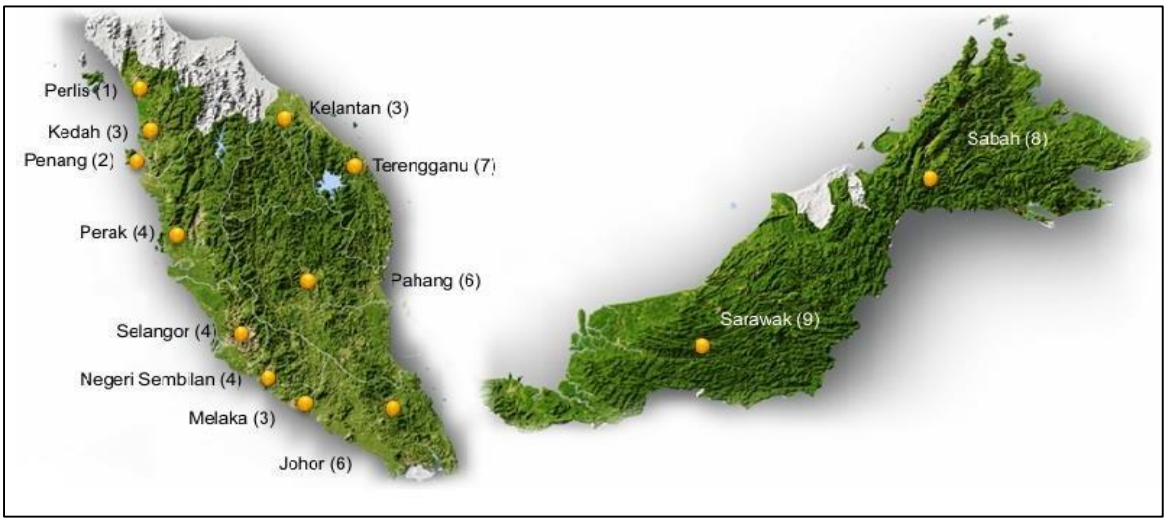

Figure 1: Proposed Eco-Tourism Clusters in Malaysia (Source: MOTAC; 2017)

3.2 Ecotourism Sustainability

Tourism sustainability involves guiding principles for tourists and guides to make personal changes towards a deeper connection with nature, deeper environmental and cultural protection efforts, and stronger ties to the global communities (Rosenberg, Lynch, and Aage, 2021). Meanwhile, Lishan et al. (2022), utilising the application of scientometrics in their research found the ecotourism field is over a broad spectrum of different disciplines and is therefore interdisciplinary. The research defines three stages in the development of ecotourism: human influence, the provision of ecosystem services, and sustainable development. Culture is essential in ecotourism as it enhances the visitor experience and helps to preserve regional customs and heritage. A study done by Chan et al. (2020), in some areas of Langkawi discovered that this conservation culture on the main island of Langkawi is reinforced by particular core values and norms. These values and norms constitute the basis of social networks among stakeholders, which are vital to enhancing the development of eco-tourism sustainability in the region.

Parvaneh Sobhani et al. (2022) in their research on eco-tourism sustainability indicators in Iran summarised the high sustainability rates of many areas that can be attributed to the restriction on human activities, limited visitation, and low-level of infrastructure and tourism services. Inadequate planning and monitoring affect the sustainability of different protected areas differently, such as those dedicated to education, research, conservation, and recreation, taking into consideration the ecological sensitivity and value of these areas. Therefore, understanding factors like tour experiences, and guided tours, and integrating environmental education into local communities' education is necessary to encourage sustainable consumption and promote eco-friendly behaviour

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(Stanciu et al., 2022). Moreover, enhancing eco-tourism performance in aspects like conservation, services, economic development, and regulation results in a higher level of sustainability for ecotourism (Hidayati et al., 2023). Hence, this study concentrates on tour experiences by assessing tourist sentiment towards ecotourism spots in Malaysia through the analysis of online feedback.

3.3 Electronic Word of Mouth (e- WOM) and Tourist Co-Creation Method

Nowadays, due to the rise of online platforms, most people search for travel information that can easily access information on various online platforms such as official destination and hotel websites, vlogs, as well as social media. Ababneh (2022) noted that the transmission of words online is becoming a critical requirement dictated by technical data. Siagian et al. (2022) described electronic word of mouth (e-WOM) as a form of communication formed by one person or a group of people to express positive or negative opinions through the internet. Tourists have the opportunity to share and express their thoughts about their travel experiences and effectively articulate their preferences and expectations on these platforms. This interaction highlights the concept of value co-creation which acknowledges the active involvement of tourists and service providers (Taheri et al., 2024).

Meanwhile, potential tourists like to read online reviews concerning places to visit, flights, accommodations, tourist attractions, and tour packages that provide details on costs, amenities, photos, videos, and virtual tours. The speed and quantity of information available through e-WOM, its reliable tools with real-time information, along the trust associated with it make it a highly effective tool for choosing destinations (Akina, 2023; Hoang et al., 2022). Yingying and Jianbin (2023) in their research on the impact of online review and interaction on value co-creation in the tourism virtual community found that the attributes of online reviews have a positive effect on social interaction and information exchange dimensions of social interaction. In line with this, Hoang et al. (2022) explored the aspect of ecotourism in Vietnam by utilising keywords such as sustainability, and natural resources indicating that e-WOM has a positive influence on deciding whether to buy a product or coming to a collective decision. Reviews like unique, remarkable, WOW, and significant can make a lasting impact on potential tourists. Sharing travel experiences on online platforms contributes to the cocreation value, aiding the destination operators in improving the overall destination experience (Han et al., 2022).

However, Arıca et al. (2022) examined the role of negative e-WOM in value co-destruction in the tourism industry. The study identifies that negative e-WOM can significantly damage customer citizenship behaviour and increase the odds of additional negative e-WOM. This shows that the cyclical nature of negative reviews in the travel and hospitality industry negates positive consumer experience. Yi-Fan et al. (2021), examined hotels managing negative e-WOM and turn the challenges into opportunities. The study reveales that hotel managers recognise that e-WOM impacts on reputation, revenue and customer expectations. Due to limited information about the underlying incident, and the complaint, they struggle to create personalised responses. They investigate accordingly based on internal records like daily logs or incident reports. To discover the causes of people's unhappiness, they also analyse previous reviews, travel histories, and customer

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demographics. Therefore, addressing negative feedback is crucial for maintaining a positive brand image.

Furthermore, using sentiment analysis helps measure word-of-mouth and identify areas for improvement to foster more sustainable tourist locations, integrating the understanding of tourist feelings, and experiences while discovering new opportunities (Borrajo et al., 2021). Therefore, ecotourism destinations should prioritise being widely featured on online platforms to improve visibility and boost brand reputation to bring ecotourism to a higher level of sustainability. The success of ecotourism centres on multiple factors, primarily environmental, community, social, and economic aspects. Researchers have indicated several key contributors to the success of tourism, such as the uniqueness of the location, the attractiveness of the area, convenient accessibility, government support, local community engagement, facilities and infrastructure, human expertise, promotion and tourist motivation (Sutrisno, 2024; Utami et al., 2023).

Given the importance of sustainability, which emphasises managing resources to ensure their availability for future generations, it is crucial to consider these factors that could increase the demand for ecotourism places and boost Malaysia's national income. Despite the recognised importance of these factors for sustainable tourism, there is limited research on the specific needs and critical elements for ecotourism success. Even though ecotourism principles are acknowledged as essential for sustainable tourism, their practical implementation faces challenges related to operational, structural, and cultural factors (Kia, 2021).

3.4 Sentiment Analysis

Sentiment analysis, a significant branch of natural language processing, aims to classify text into three main sentiments: positive, negative, and neutral. Many studies on sentiment analysis highlight the critical role of artificial intelligence in automatic text sentiment analysis, discussing the methods, applications, and challenges involved. This field's significance extends to individual work and daily life, aiding operators in enhancing customer satisfaction, boosting brand image, and ultimately driving revenue growth (Kian et al., 2023; Yanying et al., 2024).

Sentiment analysis and opinion mining are now pivotal tools for collecting data and informing managers and operators about their customers' feelings, indicating areas needing improvement to enhance customer experiences. Manosso and Ruiz (2021) conducted a study on tourism utilising sentiment analysis to explore its application, data sources, methodological approaches, and connection to internet tourism. They concluded that sentiment analysis aids in developing communication strategies, resulting in cost and time savings and facilitating decision-making to improve tourist attractions. Additionally, Hoang et al. (2022) noted that positive sentiment about ecotourism destinations significantly influences potential tourists' choices to visit. Eco-conscious travellers are more attracted to destinations that emphasise sustainability, environmental protection, and responsible tourism practices.

4.0 Research Process

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4.1 Overview of The Focus of The Study Area

Figure 2 displays the study area from six proposed detailed ecotourism clusters that are known to have a significant amount of competitive tourism products, with one or more major attractions concentrated in a particular geographical location. The concept of creating an ecotourism cluster aimed to bring together local operators, communities, NGOs and the government to benefit from economies of scale through the sharing of infrastructure development, marketing, advertising, labour, and human resources. The six proposed detailed ecotourism clusters; one each in Perak and Terengganu, two clusters in Sarawak, and two clusters in Sabah were selected to serve as models for other clusters (MOTAC, 2017).

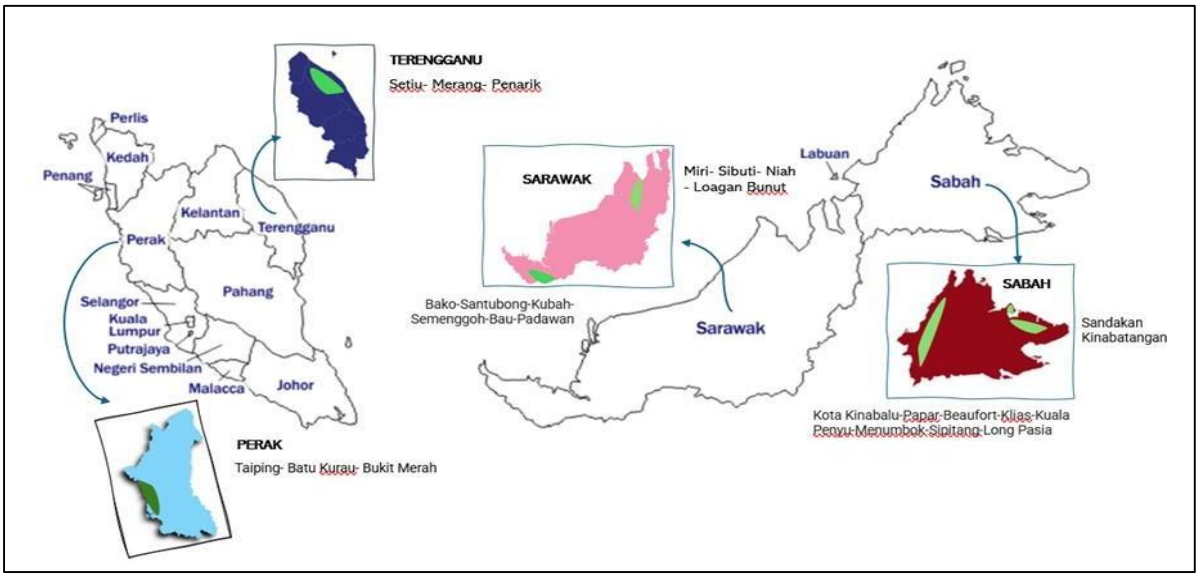

Figure 2: Study Area of Eco-tourism Cluster

Table 1 presents the distribution of scores for each cluster. This study focused on analysing reviews of several detailed ecotourism clusters as models for other clusters in Malaysia to effectively assess tourists' sentiments. Given the diverse vocabulary used in online reviews and variations in expression, it was important to use a reliable sentiment classification method (Liu, 2012).

Table 1: Distribution Number of Reviews for Each Cluster

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States	Model Cluster (Specific place)	No. of Reviews
Perak	Taiping/ Batu Kurau/ Bukit Merah	22
Terangganu	Setiu/ Merang/ Penarik	8
Sabah	Kota Kinabalu- Papar- Beaufort- Klias- Kuala Penyu- Menumbok- Sipitang- Long Pasia	45
	Sandakan/ Kinabatangan	13
Sarawak	Bako-Santubong-Kubah-Semenggoh -Bau-Padawan	9
	Miri-Sibuti-Niah-Loagan Bunut	31

This study used the Python-based Textblob library, a popular natural language processing (NLP) tool that simplifies the process of sentiment analysis. Textblob enables the extraction of sentiment polarity and subjectivity from text data. Polarity indicates the emotional direction (positive, negative, or neutral), while subjectivity measures the extent of personal opinion present in the text. According to Vijaya Kumari Yeruva et al. (2020), differences exist between human and machine annotators in sentiment analysis tasks, highlighting the potential system that integrates human input to achieve more accurate analysis of complex and unstructured text data.
Additionally, Abubakar and Uppin (2021), and Gadi and Sicilia (2023) emphasise the advantages of using Textblob for automatic feature extraction, which facilitates the determination of sentiment polarity, and subjectivity.

This skill is particularly valuable in the context of tourist feedback, where subjective evaluation plays a crucial role. Shivika Prasanna et al. (2021), for example, show the feasibility of using NLP techniques to analyse sentiments related to prior authorisations in healthcare, demonstrating the versatility of these methods in different sectors. By leveraging Textblob's features in this study, the study aimed to gain meaningful insights into tourists' sentiments in the ecotourism clusters. However, it is important to note the limitations and biases of TextBlob (Aljedaani et al., 2021; Gaganpreet Kaur et al., 2024). While TextBlob is user-friendly and efficient, it may not capture the nuances of sentiment as accurately as more complex models. It also relies on pre-trained datasets that may not fully represent the diverse linguistic and cultural context of the reviews. Despite these limitations, TextBlob was chosen for its simplicity and effectiveness in handling large volumes of text data.

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4.2 Outline of Research Process

The research process for this study includes four key components: 1 - data collection, 2: data preprocessing, 3: data analysis, 4: sentiment classification, and 5: sentiment assessment and visualisation. Therefore, this section explains the entire process starting from gathering data through web scraping and preprocessing, followed by sentiment analysis and classification using themes and word counts, and finally visualising the output. Figure 3 illustrates the entire research process.

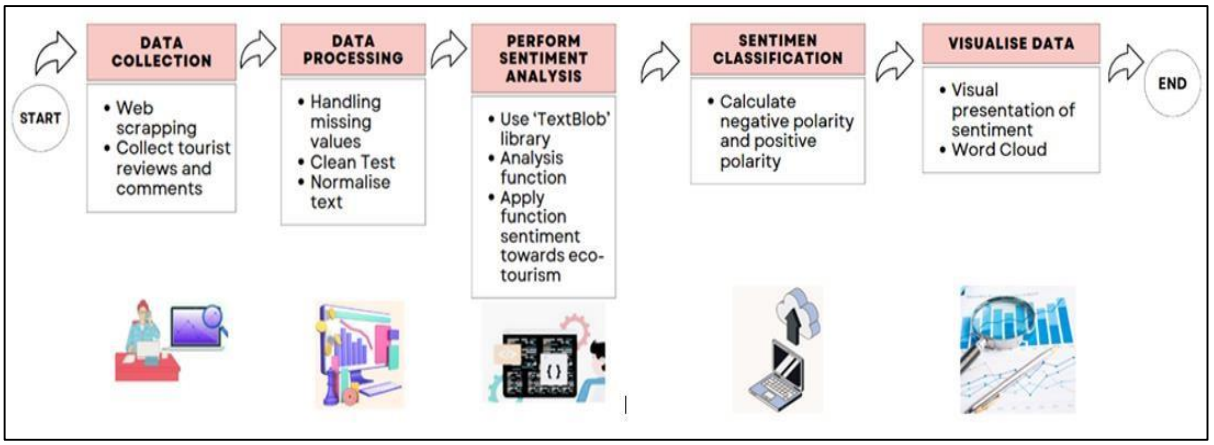

Figure 3: The Research Process

4.2.1 Data Collection

To ensure that the data used is accurate, comprehensive, and objective, this study opted for well-known and popular domestic, and international tourism websites such as TripAdvisor as data sources (Özen, 2021). Tourism websites are significant platforms for tourists to express their feelings and share experiences about various destinations and activities (Rossi, 2022). The selection criteria for reviews included relevance to the ecotourism clusters, recency (reviews from the past three years), and a minimum length of 50 words to ensure substantial content. According to Sumit Kumar and Uponika Barman Roy (2023), the data collection started with web scraping techniques using the BeautifulSoup library in Python. BeautifulSoap was employed to parse the HTML content of web pages containing the reviews. The extracted reviews were then saved in a CSV file as a data frame. Algorithm 1 shows how the web scraping techniques used pseudo code.

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```
Algorithm 1: Web Scraping and Data Storage

Input: None
Output: A CSV file containing the extracted reviews

1. Import necessary libraries:
   - requests for making HTTP requests
   - BeautifulSoup from bs4 for parsing HTML content
   - pandas for data manipulation and storage

2. Define the URL of the web page containing customer reviews:
   url = 'https://example.com/reviews'

3. Send a GET request to the web page and store the response:
   response = requests.get(url)

4. Parse the HTML content of the response using BeautifulSoup:
   soup = BeautifulSoup(response.content, 'html.parser')

5. Initialize an empty list to store the extracted reviews:
   reviews = []

6. Loop through all elements with the class 'review-text' in the parsed HTML:
   for review in soup.find_all('div', class_='review-text'):
       - Extract the text content of the review and append it to the reviews list

7. Create a DataFrame from the extracted reviews list:
   df = pd.DataFrame({'REVIEWS': reviews})

8. Save the DataFrame to a general CSV file:
   df.to_csv('reviews.csv', index=False, encoding='utf-8')
```

Algorithm 1: The Web Scraping Techniques Using Pseudo Code

The BeutifulSoup library was used for web scraping to parse the HTML content of web pages containing the reviews. The exact review is then saved in a CSV file as data frame. Once data is stored in the CSV file, the file is read by the Panda library in Python. This approach helps in managing any potential encoding issues that may arise due to the nature of diverse data structures. It is crucial to address ethical concerns related to web scraping. Permissions were sought from the websites where possible, and the study adhered to the terms of service of the platforms. Additionally, the data collected was anonymised to protect the privacy of the reviewers (Krotov et al., 2020; Brown et al., 2024).

4.2.2 Data Pre-processing

After data is stored in a CSV file, the file is loaded into Pandas Dataframe. The data preprocessing starts with filling NaN into ‘reviews’ columns with empty strings, removing punctuation, converting to lowercase text, tokenising text, and removing all stop words such as ‘is’, ’the’, ’and’ and single letter words such. This steps to ensure that data are ‘clean’ and ready for further processing.

4.2.3 Perform Sentiment Analysis and Classification

The sentiment analysis process begins with importing the necessary library such as

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TextBlob in Python (Kedia & Rasu, 2020). The sentiment analysis function through TextBlob is used to calculate the polarity (sentiment score) and subjectivity (objectivity score) for each review, classifying sentiment as 'positive', 'negative', or 'neutral' based on the polarity score. This function is applied to each review column in the dataframe, and results are stored in new columns. The distribution of sentiment labels is then calculated and converted into percentages for easier interpretation. Summary statistics for polarity, and subjectivity are generated to understand the overall sentiments, and objectivity of the reviews from tourists. The word cloud is created from all the reviews to visualise the most common words and identify the themes. The process is written in pseudo-code as in the following algorithms 2.

```
Algorithm 2: Sentiment Analysis Process

Input: Preprocessed DataFrame df containing the column 'cleaned_reviews'
Output: DataFrame df with additional columns for polarity, subjectivity, and sentiment labels;
        a word cloud image file

1. Import necessary libraries:
   - pandas for data manipulation
   - TextBlob for sentiment analysis
   - WordCloud and matplotlib for visualization

2. Define the sentiment analysis function:
   Function analyze_sentiment(text):
       analysis = TextBlob(text)
       polarity = analysis.sentiment.polarity
       subjectivity = analysis.sentiment.subjectivity
       sentiment_label = 'positive' if polarity > 0 else 'negative' if polarity < 0 else 'neutral
       Return {
           'polarity': polarity,
           'subjectivity': subjectivity,
           'sentiment_label': sentiment_label
       }

3. Apply sentiment analysis to each review:
   sentiment_results = df['cleaned_reviews'].apply(analyze_sentiment)
   df['polarity'] = sentiment_results.apply(lambda x: x['polarity'])
   df['subjectivity'] = sentiment_results.apply(lambda x: x['subjectivity'])
   df['sentiment_label'] = sentiment_results.apply(lambda x: x['sentiment_label'])

4. Calculate sentiment distribution:
   sentiment_distribution = df['sentiment_label'].value_counts(normalize=True) * 100
   Print "Sentiment Distribution (Percentage):"
   Print sentiment_distribution

5. Generate summary statistics:
   summary_stats = df[['polarity', 'subjectivity']].describe()
   Print "Summary Statistics for Polarity and Subjectivity:"
   Print summary_stats

6. Create a word cloud:
   all_reviews = ' '.join(df['cleaned_reviews'].astype(str))
   wordcloud = WordCloud(width=800, height=400, background_color='white').generate(all_reviews)
   plt.figure(figsize=(10, 5))
   plt.imshow(wordcloud, interpolation='bilinear')
   plt.axis('off')
   plt.title('Word Cloud of Reviews')
   plt.show()
   plt.savefig('wordcloud.png')
```

Algorithms 2: Pseudo-code

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5. DISCUSSION

The sentiment analysis results presented in Table 2 provide insights into the average polarity, subjectivity, and sentiment labels for each cluster. Cluster 1 with 22 reviews has a high average polarity of 0.300268, and subjectivity of 0.588317, with 100% positive sentiment. This indicates that tourists in this cluster are highly satisfied with their experiences, expressing strong positive emotions, and personal opinions. In contrast, cluster 2 with 8 reviews has an average polarity of 0.169029, and subjectivity of 0.507827, with 75% positive, and 25% negative sentiment. The presence of negative sentiment suggests that there are areas for improvement in this cluster. Cluster 3, the largest with 45 ratings, has an average polarity of 0.342349, and subjectivity of 0.571626, with 91.11% positive, 2.22% neutral, and 6.67% negative sentiment. The high positive sentiment indicates overall satisfaction, but the presence of neutral, and negative sentiments suggested that some tourists had mixed or negative experiences.

Meanwhile, cluster 4 with 13 reviews has an average polarity of 0.219188 and subjectivity of 0.511946, with 100% positive sentiment. Thus, this cluster shows consistent positive feedback, indicating high tourist satisfaction. Similarly, cluster 5 with 9 reviews has an average polarity of 0.199568 and subjectivity of 0.493064, with 100% positive sentiment. This cluster also shows consistent positive feedback. Finally, cluster 6 with 29 reviews has an average polarity of 0.233443 and subjectivity of 0.503636 with 89.66% positive, 6.90% neutral and 3.45% negative sentiment. The presence of neutral, and negative sentiments in this cluster suggests that while most tourist are satisfied, several areas need attention to improve the overall experience. Overall, the clusters show predominantly positive sentiments with varying degrees of polarity and subjectivity.

Table 2: Sentiment Analysis Results by Cluster

Cluster	N	Average Polarity	Average Subjectivity	Sentiment Labels		
				Positive (%)	Neutral (%)	Negative (%)
1	22	0.300268	0.588317	100.00	0.00	0.00
2	8	0.169029	0.507827	75.00	0.00	25.00
3	45	0.342349	0.571626	91.11	2.22	6.67
4	13	0.219188	0.511946	100.00	0.00	0.00
5	9	0.199568	0.493064	100.00	0.00	0.00
6	29	0.233443	0.503636	89.66	6.90	3.45

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These results are supported by existing literature on sentiment analysis in the tourism sector, as discussed by Borrajo-Millan et al. (2021) that emphasise the importance of sentiment analysis in measuring the quality and sustainability of buildings in tourism destinations. Similarly, Han et al. (2022) demonstrate the feasibility of using NLP techniques to analyse sentiment related to tourism and emphasise the versatility of these methods in different sectors. The primarily positive sentiment observed in this study is consistent with the findings of Nor Hasliza Md Saad and Zulnaidi Yaacob (2021), who used sentiment analysis to identify key attributes that contribute to tourist satisfaction in Penang, Malaysia.

Table 3 highlights the key themes and most popular words for each cluster, providing a deeper understanding of the topics discussed in the reviews. As shown, cluster 1 focuses on nature, service, culture, adventure, and relaxation, with common words like ‘lake’, ‘place’, and, ‘beautiful’. Cluster 2 also emphasises the same themes as Cluster 1, with common words like ‘camp’, island’ and ‘turtle’. Cluster 3, which has the most reviews, highlights words such as ‘trip’, ‘guide’, and ‘experience’, indicating a strong focus on tour activities. Meanwhile, cluster 4 mentions the words ‘sanctuary’ and ‘visit’ with a focus on wildlife and conservation efforts. Then, Cluster 5 emphasises ‘feeding’ and ‘orangutans’ suggesting concentration on wildlife interaction. Finally, Cluster 6 attempts to focus on adventure and exploration. These key themes and common words provide valuable realisations into the main topics and experiences discussed in the reviews for each cluster.

Table 3: Key Themes and Words Clouds by Cluster

Cluster	Key Themes	Most Comment Words	Word Cloud
1	Nature, Service, Culture, Adventure, Relaxation	lake: 17 place: 13 taiping: 13 one: 13 around: 11 beautiful: 11 walk: 10 road: 10 visit: 8 many: 8	

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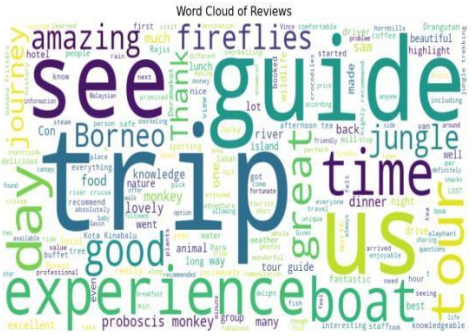
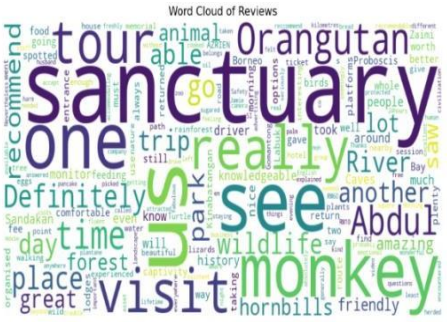
2	Nature, Service, Culture, Adventure, Relaxation	camp: 9 island: 8 see: 7 turtle: 7 place: 6 coral: 6 sea: 6 eggs: 6 people: 5 malay: 5	
3	Nature, Service, Culture, Adventure, Relaxation	trip: 41 guide: 30 us: 30 tour: 26 see: 26 monkeys: 23 also: 23 experience: 22 jungle: 22 good: 20	
4	Nature, Service, Culture, Adventure, Relaxation	sanctuary: 14 us: 12 see: 9 really: 6 visit: 6 one: 6 like: 6 abdul: 5 time: 5 definitely: 5	
5	Nature, Service, Culture, Adventure, Relaxation	feeding: 13 orangutans: 9 also: 9 morning: 8 saw: 8 visit: 8 see: 8 centre: 8 us: 7 semenggoh: 7	

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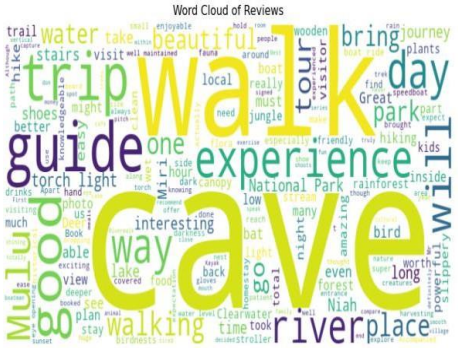
6	Nature, Service, Culture, Adventure, Relaxation	caves: 50 walk: 26 cave: 25 guide: 17 trip: 16 good: 16 park: 15 experience: 14 mulu: 11 river: 11	

These are consistent with Fennell (2020) who highlighted the importance of ecotourism in providing unique and memorable experiences, which is reflected in the positive sentiments observed in this study. Furthermore, Stanciu et al. (2022) demonstrated the role of community engagement and environmental education in promoting sustainable ecotourism, as evidenced by the key themes found in the reviews.

By comparing the clusters, it is evident that clusters 1, 4, and 5 have the highest positive sentiments with no neutral or negative reviews, indicating high tourist satisfaction. However, cluster 3, despite having the most reviews, shows a small percentage of neural and negative sentiments. This suggests that while the overall experience is positive, there are specific areas that need improvement. Moreover, cluster 2 has the highest percentage of negative sentiment (25%), indicating significant dissatisfaction among some tourists. This could be due to specific issues such as service quality, infrastructure, or environmental factors that need to be addressed. Additionally, cluster 6, with a mix of positive, neutral, and negative sentiments, suggested that while the overall experience is positive, several areas require attention to enhance tourist satisfaction. The neutral sentiments in clusters 3 and 6 imply that some tourists had mixed feelings about their experiences. This could be due to factors such as expectations not being fully met or minor inconveniences during their visit.

Thus, managing ecotourism effectively is essential for sustainable development, fostering environmental conservation, and community well-being. However, its success rests on careful planning, regulation, and continuous evaluation (Prakash Seervi, 2023). Ecotourism research has grown rapidly, evolving through three distinct phases: human disturbance, ecosystem services, and sustainable development (Han et al., 2022). The key challenges include ensuring that the initiative truly contributes to sustainability rather than simply exploiting the desirability of commercial gain. Achieving a balance between environmental conservation and economic benefits is a major concern. Although sentiment analysis in ecotourism is important, it is not being fully exploited.

Existing studies used various data sources and machine learning techniques for sentiment classification (Nikhil Kumar Singh et al., 2018; Ullah et al., 2020; Praphula Kumar Jain et al., 2020), but gaps remain in integrating feedback with sustainable development (Nor Hasliza Md Saad & Zulnaidi Yaacob , 2021; Lingling et al., 2023). Thus, this study offers suggestions for sustainable development by identifying salient attributes and assessing the

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emotional tone of the tourist experience to highlight areas for improvement. However, the analysis also highlights opportunities for improvement, particularly in clusters with a higher proportion of neutral or negative sentiment. By addressing these issues, ecotourism operators can further increase tourist satisfaction and promote a sustainable tourism industry. Integrating sentiment analysis into sustainable development practices can help ecotourism not only thrive but also contribute positively to environmental protection and community well-being.

6. CONCLUSION

The sentiment analysis of tourist reviews across six eco-tourism clusters in Malaysia reveals predominantly positive sentiments, highlighting the success of eco-tourism efforts in providing satisfying and memorable experiences for visitors. The analysis shows that the clusters exhibit varying degrees of polarity and subjectivity, with key themes such as nature, service, culture, adventure, and relaxation emerging as significant factors contributing to tourist satisfaction. These results align with the existing studies that emphasises the importance of sentiment analysis in measuring the quality and sustainability of tourism destinations (Mehraliyev et al., 2022; Ning et al., 2021; Sánchez-Núñez et al., 2020). Research by Borrajo-Millan et al. (2021) and Han et al. (2022) have demonstrated the feasibility of using NLP techniques to analyse sentiment related to tourism, affirming the versatility and relevance of these techniques in different sectors.

Moreover, the findings resonate with the work of Nor Hasliza Md Saad and Zulnaidi Yaacob (2021), who identified key attributes that enhance tourist satisfaction in Penang, Malaysia. The consistent positive sentiments across clusters underscore the effectiveness of Malaysia's eco-tourism initiatives in delivering unique and enriching experiences, as highlighted by Fennell (2020). However, challenges identified in the National EcoTourism Plan 2016- 2025, such as insufficient incentives for investors, funding difficulties for SMEs and local communities, and ineffective promotion of potential investments, highlight areas for improvement. To address these challenges and enhance the sustainability of ecotourism, several critical insights and calls to action are proposed.

Firstly, the government should introduce targeted incentives such as tax breaks, grants, and low-interest loans specifically for ecotourism projects to attract more investment and encourage private sector involvement. Secondly, providing financial and technical support to SMEs, and local communities is essential. This can be achieved through microfinance schemes, capacity-building programmes, and partnerships with larger organisations. Thirdly, developing a comprehensive marketing strategy that highlights the unique selling points of each ecotourism cluster can attract more tourists. Utilising digital marketing, social media campaigns, and collaborations with travel influencers can enhance the visibility and appeal of these destinations. Addressing these issues will enhance tourist satisfaction and promote a more sustainable tourism industry. Thus, integrating sentiment analysis into sustainable development practices can help ecotourism thrive in exile positively impacting environmental protection and community well- being. This is in line with Stanciu et al. (2022) and Hidayati et al. (2023) that enhancing ecotourism performance results in a higher level of sustainability for ecotourism and promotes eco-friendly behaviour. Finally,

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attracting more tourists and improving the reputation of ecotourism sites as attractive and sustainable experiences can be achieved by promoting them using efficient marketing techniques such as a strong online presence and good word of mouth.

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