

## Smart tourism at Ver-O-Peso complex in the city of Belém (Brazil): a data-driven analysis

### ABSTRACT

The Ver-O-Peso complex is one of the most famous tourist attractions in the city of Belém, Pará, Brazil. It is possible to find a vast variety of products, regional food, and beverages from the Amazon region there, making it a unique and interesting destination. For these reasons, numerous visitors frequent the market every year and a part of them shares their impressions on the TripAdvisor platform. Data-driven analysis is essential for smarter, more efficient, and responsive decision-making in smart cities. The objective of this research was to identify positive and negative aspects of Ver-O-Peso, based on the 3,749 reviews extracted from TripAdvisor. The IBM Watson was used to classify the sentiment of the evaluations. Through the CRISP-DM methodology, it was found that 66.94%, 23.18%, and 9.88% of the evaluations were positive, negative, and neutral, respectively. Among the positive facets, many visitors praised the diversity of products available for sale and the gastronomy (such as fried fish with açaí). Regarding the negative facets, several tourists reported issues related to hygiene, infrastructure, and security. It is worthwhile to analyze data to identify improvements in highly visited tourist attractions.

**KEYWORDS:** Smart city management. User-generated content. Management of tourist attractions. TripAdvisor.

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database or structured file. The analysis of reviews can be performed using Natural Language Processing (NLP), enabling automated analysis. NLP tools utilize artificial intelligence (AI) techniques capable, for example, of extracting the predominant sentiment in a text within fractions of a second and with high accuracy (Chowdhary, 2020).

Smart cities integrate technology and data-driven insights to enhance urban life and decision-making. In this context, tourism platforms, like TripAdvisor, provide valuable user-generated data that can support smart city development (Stübinger & Schneider, 2020). By applying AI and NLP techniques to analyze reviews, city managers can better understand public perceptions, identify areas for improvement, and design more responsive urban policies. Such automated analysis not only optimizes tourism management but also contributes to more efficient, sustainable, and citizen-centered smart city strategies (Kaluarachchi, 2022).

This research aimed to identify positive and negative aspects of the Ver-O-Peso market in Belém do Pará, Brazil, by analyzing reviews from the TripAdvisor platform and classifying sentiment in the posts using IBM Watson, making it possible to automatically and intelligently identify aspects that need improvement by the government. Therefore, this study contributes to the broader framework of smart cities, where data-driven insights support more responsive urban planning. Identifying sentiment patterns and user perceptions enables public managers to prioritize interventions, enhance the quality of services, and promote more sustainable and efficient governance aligned with citizens' real needs.

Section 2 of this work presents related works; section 3 covers the theoretical framework; section 4 approaches the methodology; section 5 presents the results and discussion; and the section 6 provides the final considerations.

## **RELATED WORKS**

This section presents related studies, published in other scientific journals, that address and support the same topics examined in the smart tourism study of the Ver-o-Peso.

Ukpabi e Karjaluoto (2016) reviewed 54 studies (2005–2016) on user-generated content (UGC) to identify antecedents of its use in travel planning and the theories, models, and frameworks applied. They found that UGC adoption is influenced by user, source, content, and response attributes. The reviewed studies employ diverse and heterogeneous theoretical approaches, mainly from information systems, socio-psychology, and management. Among the antecedents, trust shows the strongest influence on attitude toward UGC.

Sarker (2022) analyzed that extracting insights from urban data and creating data-driven models is essential for automating and enhancing city systems. Smart city data science focuses on analyzing information from sensors, connected devices, and other sources to uncover patterns that support better decisions and more intelligent public services. Artificial intelligence, especially machine learning, deepens understanding of city dynamics and enables more effective computational solutions for real-world applications. This work also outlines ten key research challenges for advancing data-driven smart cities and offers a broad

conceptual overview to guide researchers, industry professionals, and policymakers from a technological perspective.

Taecharungroj et al. (2021) conducted the processing of over 41,000 TripAdvisor reviews of 61 markets in the United Kingdom to investigate visitors' experiences and identify potential management improvements for these locations, supporting decision-making processes. Five types of experiences were identified using AI algorithms: atmosphere, merchandise, local variety, food, and disappointment, along with the underlying factors driving positive experiences.

Dutra & Gosling (2021) used various sentiment analysis methods to categorize approximately 700 TripAdvisor reviews of the Museum of Tomorrow (Rio de Janeiro, Brazil). The study tried to identify parameters that would assist museum managers in assessing the quality of information provided by their institutions. Negative opinions highlighted issues such as ill-informed staff, disorganized museum information, and a lack of internal signage. Positive opinions emphasized the importance of the information conveyed in the exhibitions and the high interactivity with the museum's collection. These findings provide guidance for decision-making to optimize museum management.

Wang & Kirilenko (2021) analyzed over 27,000 reviews of the Grand Canyon in the United States, posted on TripAdvisor by visitors from ten different countries, with the aim of identifying differences in the sentiments expressed by them. They found that the majority of comments were positive, but significant regional differences existed, with Europeans and Japanese expressing less satisfaction with their visits. They concluded that the reviews reflected real differences in the sentiments of tourists from diverse origins.

Bunders & Varró (2019) examined how municipal and civil society stakeholders in five Dutch cities interpret and address challenges linked to data-driven urban practices. Using the lens of problematization, it argued that how stakeholders define these issues shapes their implementation and reflects political dynamics. The case study showed that actors recognize not only practical obstacles but also ethical and societal concerns, responding with a mix of technological, legal-political, organizational, informational, and participatory strategies. However, direct contestation of smart-city policies remains limited. The paper concluded that further research is needed to understand the institutional forces that enable or hinder renewed political debate around smart-city initiatives.

Sangkaew & Zhu (2022) conducted an analysis of approximately 2,900 TripAdvisor reviews to explore the sentiment of people visiting local markets in the city of Phuket, Thailand. Based on the frequency and importance of the analyzed reviews, they identified five positive and five negative terms that provide insights into tourists' experiences when visiting the local markets in the region. This enabled them to identify practical implications that tourism professionals and stakeholders in the city should be aware of to improve the location.

De Souza et al. (2024a) used 244 reviews extracted from the TripAdvisor platform to measure the satisfaction level of visitors to the BioParque Vale Amazônia and the Carajás National Forest. The reviews were automatically classified by sentiment by ChatGPT: 90% of them are positive, 4% neutral, and 6% negative. Additionally, through this analysis, it was possible to identify issues such as lack of information on official websites and cleanliness problems at the sites.

Based on the analyzed studies, there is growing concern within the scientific community working with TripAdvisor data to develop innovative approaches that address the contemporary demands. The contributions presented provide relevant theoretical and methodological support, although gaps remain to be explored. Therefore, the present work contributes to advancing the discussion by proposing a complementary perspective that engages with existing initiatives while introducing original elements that may contribute to deepen future investigations, with a focus on the Ver-o-Peso.

## **THEORETICAL FRAMEWORK**

This section outlines the theoretical framework supporting this study, covering key concepts related to data extraction (via web scraping), organization, and quantitative and qualitative analysis (sentiment analysis and data summarization) for future decision-making.

Web scraping is a technique used to automatically extract information from web pages, enabling the collection of large volumes of structured data from sources that originally present content in a dispersed or unstructured manner. Through scripts or specialized tools, the process identifies HTML elements, captures text, tables, images, or metadata, and organizes them into formats suitable for analysis. This approach is widely applied in academic research, digital media monitoring, market studies, and the construction of dynamic databases, especially when continuous updates or a variety of sources make manual collection impractical (Khder, 2021; Uzun, 2020).

Sentiment analysis consists of a set of computational methods aimed at automatically identifying emotions, opinions, or evaluations expressed in texts such as comments, social media posts, or user reviews. Using NLP techniques and machine learning models, this analysis classifies content into categories such as positive, negative, or neutral, and may also detect more complex nuances, such as irony or emotional intensity. This methodology is important for understanding public perceptions, supporting strategic decisions, and identifying behavioral patterns, contributing to studies involving public opinion, consumer behavior, and policy evaluation (Wankhade et al., 2022; Devika et al., 2016).

Data summarization using ChatGPT involves employing advanced language models to generate coherent, concise, and context-aware summaries from large volumes of textual information. The model can identify central ideas, remove redundancies, and reorganize information clearly, preserving the most relevant conceptual elements. This technique is useful in academic and professional settings, particularly when analyzing long documents, reports, transcripts, or qualitative datasets. As a result, automated summarization supports decision-making, evidence synthesis, and efficient communication of findings (El Akraoui et al., 2025; Tariq et al., 2023).

## **METHODOLOGY**

To accomplish the objective of this study, the CRISP-DM (Cross Industry Standard Process for Data Mining) methodology was employed due to its

widespread recognition, comprehensive documentation, and adaptable phase structure (Schröer et al., 2021; De Souza, 2024b).

The data used in this study was collected from the TripAdvisor website in January 2025, using a web scraping software developed in Python (version 3.10.6), employing the Selenium framework (version 4.8.3) and IBM Watson Natural Language Processing SDK (Software Development Kit) version 1, released on April 7, 2022.

Selenium allows the access to a web page, enabling the reading and location of its hypertexts, such as texts, images, videos, links, and other content. Access to this information is programmed, enabling the automation of the data collection process, as TripAdvisor reviews follow the same HTML structure.

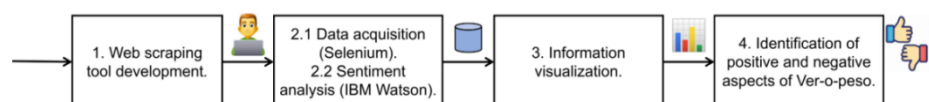
The IBM Watson SDK was used to classify, also in an automated manner, whether a given text has a positive, negative, or neutral sentiment. In addition to this classification, the tool generates a precision coefficient with a range from -1 to 1, where a value closer to -1 indicates a negative sentiment, a value closer to 1 indicates a positive sentiment, and 0 indicates a neutral sentiment. The IBM Watson solution was chosen because of its ease of integration with Python and because there are free plans available for researchers.

This research focused on reviews submitted in TripAdvisor between 2011 and 2024, resulting in a dataset with 14 features and 3,749 rows. The features are the following information about the reviewers: hometown, hometown's state, number of contributions, visit's date, visit's type (alone, with friends, couples, family, business). Besides, other features consider the following details about the review: number of likes, star rating assigned to Ver-O-Peso (from 1 to 5), title, title's sentiment, title's sentiment coefficient, review, review's sentiment, review's sentiment coefficient, review's date.

TripAdvisor was chosen because it offers more comprehensive and tourism-focused user reviews with detailed qualitative insights, making it more suitable for analyzing visitor perceptions and experiences than general platforms such as Google Maps.

The dataset was stored in a spreadsheet, and analytical graphs were generated within it. Additionally, a word cloud was created to examine the frequency of the most used terms. These results were used to identify the positive and negative aspects of the Ver-O-Peso market, which will be presented in the next section. Figure 2 summarizes the methodology used in this study.

Figure 2 - Summary of the methodology used in the study



Source: authors (2026)

It is important to mention that ChatGPT (version 3.5) was used to perform extractive summarization of each type of sentiment in the post: negative, positive and neutral. Six data clusters were used empirically. The prompt used was:

“Summarize the following reviews into six different topics: <reviews by sentiment type>”.

The next section shows the results achieved and discusses them in relation to other scientific studies.

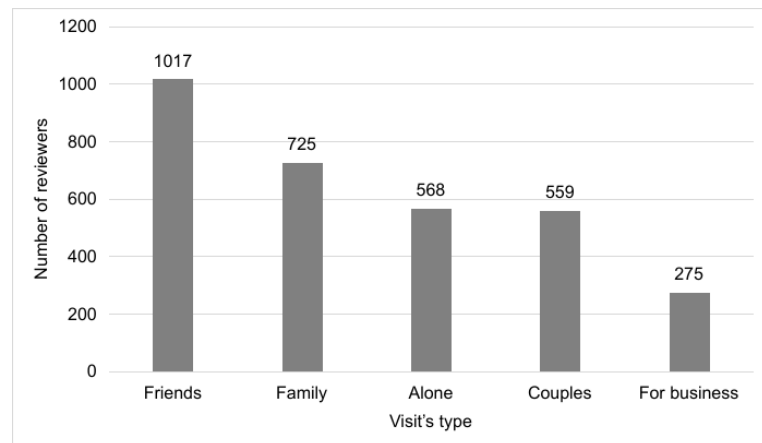
### DEVELOPMENT (RESULTS AND DISCUSSION)

This section presents the statistical results and sentiment analysis conducted by IBM Watson. In addition, a comparison is made with other papers.

#### Evaluation of the Urban Data

The exploratory statistics on the provided data revealed important information about the type of visits to the establishments. It was observed that the majority of visits were made with friends and family, numbered at 1,017 and 725, respectively. Visits made alone and for business purposes also showed significant numbers, a 568 and 559, respectively. Additionally, there was a considerable number of unidentified visits (not specified by the user at the time of posting), with a total of 275. These pieces of information are valuable for better understanding visitor behavior and can assist in making strategic decisions to improve the customer experience at the establishments. Figure 3 presents a column chart illustrating the types of visits to the market.

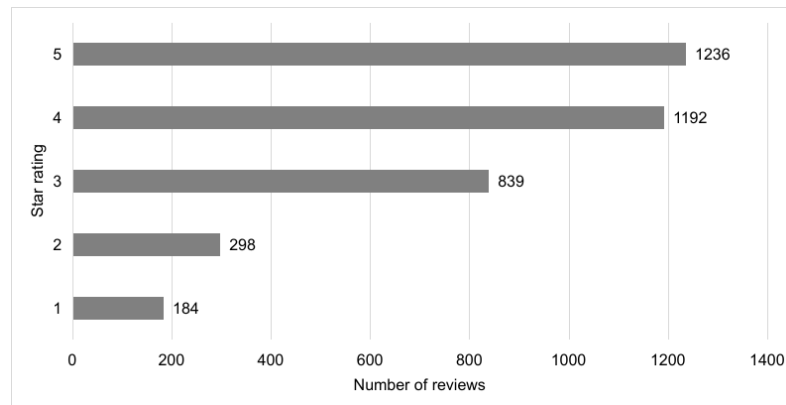
Figure 3 - Types of tourist groups



Source: authors (2026)

One of the most important data points regarding the interaction with the Ver-O-Peso market is the star ratings. It can be observed that the majority of establishment reviews were positive, with 1,236 five-star ratings. Four-star ratings were also significant, totaling 1,192 reviews. On the other hand, one-star ratings were the least common, with only 184 reviews. Two-star and three-star ratings had intermediate counts, with 298 and 839 reviews, respectively. The average of the star ratings is 3.80. Figure 4 presents the bar chart depicting the distribution of 'likes'.

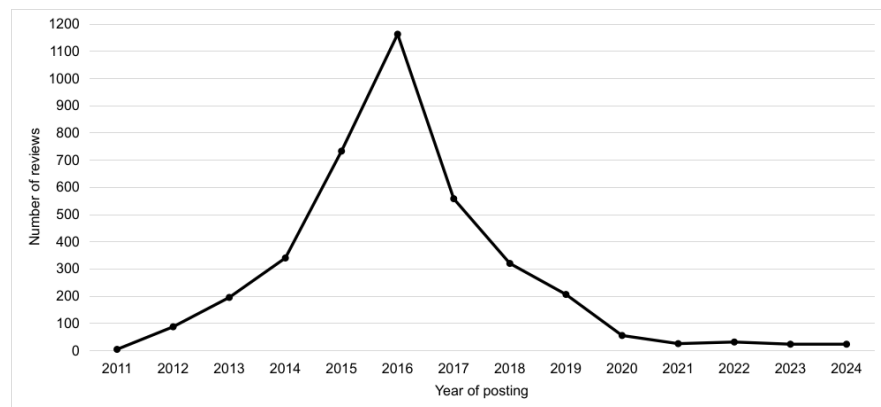
Figure 4 - Star rating from tourists



Source: authors (2026)

Analyzing Figure 5, which shows the line chart of reviews recorded per year, it is noticeable that there was a gradual increase in the number of reviews over the years, with sharp drops starting from 2016. The year with the highest growth was 2016, which recorded 1,162 reviews, followed by 2015 with 732 reviews. On the other hand, 2011 had only three recorded reviews, indicating a modest beginning of the use of the TripAdvisor platform.

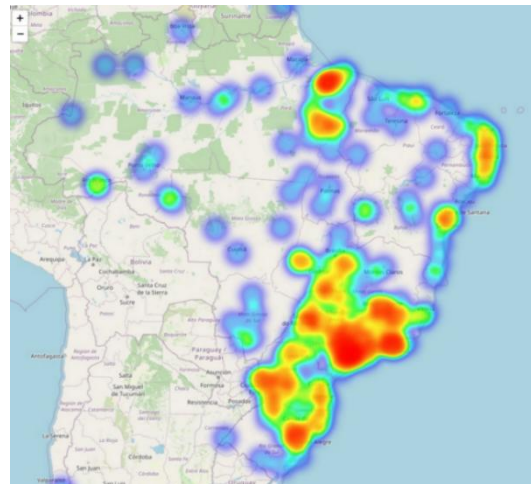
Figure 5 - Number of reviews by year.



Source: authors (2026)

The heatmap in Figure 6 represents the main Brazilian cities that visited the Ver-O-Peso market during the years indicated in the study. It is notable that there are many visitors from locals of the capital of Pará (Belém), São Paulo, Brasília, Minas Gerais, Rio Grande do Sul, Bahia and Pernambuco (from all regions of the Brazil).

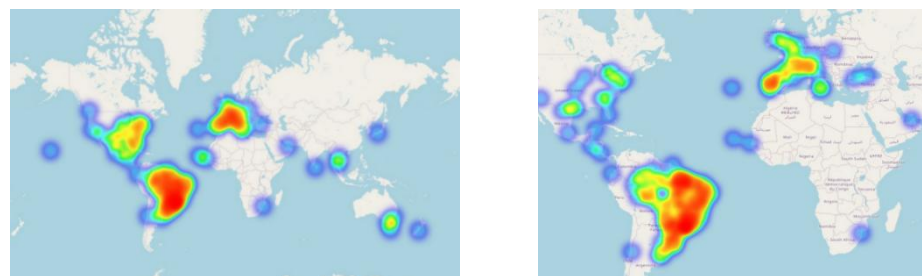
Figure 6 - Heatmap by the Brazilian visitors.



Source: authors (2026)

Through Figure 7, it is possible to identify the main regions of the world from which Ver-O-Peso visitors originate, according to the analyzed data. It is clear that many Europeans and North Americans have visited the market.

Figure 7 - Global analysis



(a) Global heatmap.

(b) Europe, Africa and Americas heatmap.

Source: authors (2026)

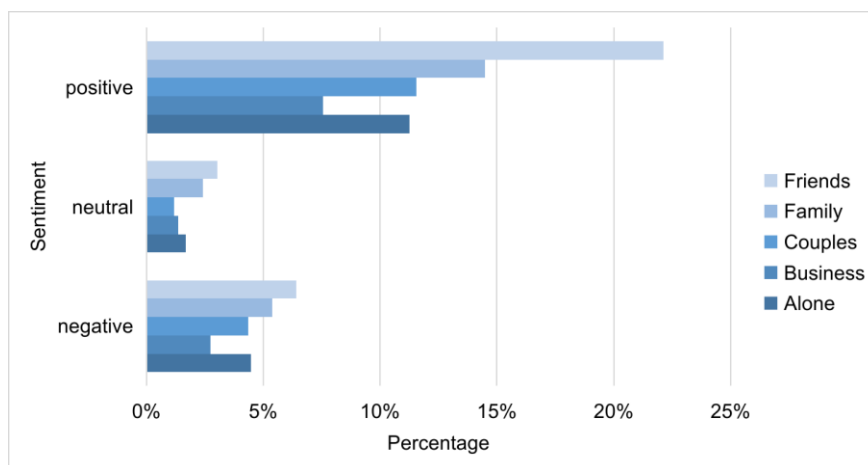
Figure 8 presents the word cloud of the reviews. Semantically irrelevant words (known as stop words) that do not contribute to the identification of positive and negative aspects of Ver-O-Peso were excluded. Additionally, words with 200 or more occurrences were considered. It can be observed that among the most frequent words are: “fish”, “fruits”, “everything”, “chestnuts”, “açai”, “craftsmanship”, “culture”, “herbs”, highlighting the variety of products sold at the market. However, “bad”, “dirty”, “careful” are prominent words that emphasize negative aspects regarding hygiene, safety, and infrastructure.

Figure 8 - Word cloud of reviews



Besides, the sentiment by type of visit can be analyzed by Figure 9. It is possible to observe that there are more positive reviews from Ver-o-peso visitors accompanied by friends, family and couples. When visitors are alone, the reviews tend to be negative.

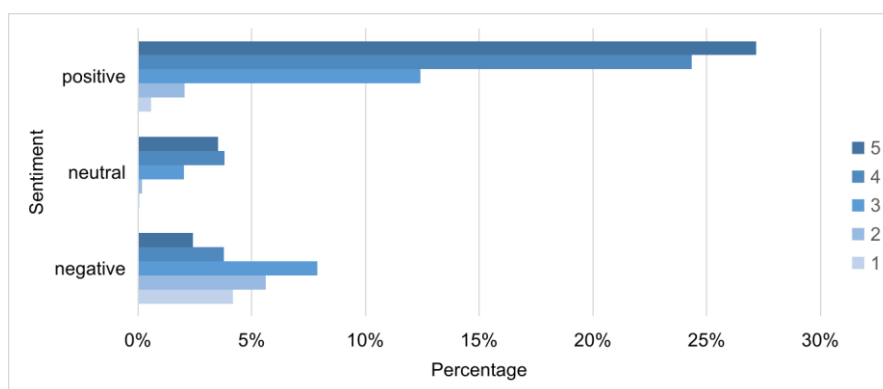
Figure 9 - Sentiment analysis by type of visit



Source: authors (2026)

Another analysis is about the sentiment of reviews in relation to star ratings. Through Figure 10, it is possible to conclude that IBM Watson holds high accuracy, as most reviews with five, four, and three stars are classified as positive, while most with one and two are classified as negative sentiment. This ensures the reliability of IBM Watson.

Figure 10 - Sentiment by star rating



Source: authors (2026)

### Summarization of reviews grouped by sentiment using ChatGPT

As mentioned in the methodology section, ChatGPT was used to perform an extractive summary of each sentiment set from the reviews, and the prompt used to summarize the reviews was: "Summarize the following reviews into six different topics: <pasted reviews by sentiment type>". Table 2 displays highlighted aspects from each sentiment class considering all reviews. Once again, it confirms the

dissatisfaction with the hygiene and safety conditions of Belém-PA's most famous tourist spot. On the other hand, the positive reviews, and even the ones classified as neutral, highlight the variety of regional products and Amazonian culinary found at Ver-O-Peso.

Table 2 - Summarization by ChatGPT

Sentiment	ChatGPT's summarization
Positive	<p>I. Cultural potential: Despite the criticisms, some posts acknowledge that the market offers a variety of products and reflects Paraense culture in terms of food, herbs, and handicrafts.</p> <p>II. Variety of products: Visitors highlight the incredible variety of products available at the market, including fruits, fish, typical foods, medicinal herbs, crafts, and more.</p> <p>III. Paraense cuisine: Many praise the opportunity to taste delicious Paraense cuisine, including dishes like açai with fried fish, fresh fish, tacacá, and other typical regional delicacies.</p> <p>IV. Culture and local experience: Tourists emphasize that the Ver-O-Peso Market offers an authentic experience of local Paraense culture, with the chance to interact with friendly local people and learn about regional traditions.</p> <p>V. Diversity of regional products: Many visitors appreciate the opportunity to purchase regional products such as Brazil nuts, exotic fruits, local crafts, and unique spices.</p> <p>Affordable prices: Several reviewers highlight that prices are reasonable and inviting, making the Ver-O-Peso Market a great place to shop and enjoy local food without spending too much.</p>
Neutral	<p>I. Need for restructuring: Several visitors mentioned that the market lacks infrastructure to accommodate tourists and needs improvements in cleanliness, organization, and security.</p> <p>II. Cultural attraction: Many appreciate the market as part of the local culture and consider it a must-visit in Belém.</p> <p>III. Traditional but disorganized: While it's a traditional location, some people noted that the market is dirty and disorganized. However, it's good for purchasing items like Brazil nuts, shrimp, and salted fish.</p> <p>IV. Paraense cuisine: The food stalls offer a Paraense gastronomic experience, with highlights including "filhote" (a type of fish) and açai.</p> <p>V. Variety and handicrafts: The Ver-O-Peso Market is known for its variety of products, including handicrafts, local foods, and other goods.</p> <p>Be cautious with security: Some visitors cautioned about the lack of security in the market and recommend taking precautions when visiting the area.</p>
Negative	<p>I. Dirt and disorganization: Many visitors complain about the dirt and disorganization in the market. Dirty floors, scattered litter, and a lack of cleanliness are often mentioned as problems.</p> <p>II. Lack of security: Several visitors report concerns about security in the market. Robberies, pickpockets, and a sense of insecurity are mentioned in several posts.</p> <p>III. Bad smell: Bad smell is another frequently mentioned negative point. The odor of urine, garbage, and other unpleasant smells is highlighted.</p> <p>IV. Lack of hygiene: The lack of hygiene in some stalls and the exposure of food without proper protection are concerns for some visitors.</p>

	<p>V. Overall negative appearance: Many visitors describe the market as ugly, poorly maintained, and in bad condition. Some mention that they expected more from such a famous tourist spot.</p> <p>Cultural potential: Despite the criticisms, some posts acknowledge that the market offers a variety of products and reflects Paraense culture in terms of food, herbs, and handicrafts.</p>
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Source: authors (2026)

## FINAL CONSIDERATIONS

This research is relevant to smart tourism in Ver-o-peso, because, based on the analysis of the 3,749 reviews extracted from TripAdvisor platform, and on the sentiment classification using IBM Watson and ChatGPT extractive summarization, this study identified positive and negative aspects of the Ver-O-Peso market in Belém, Pará.

As positive aspects, the results showed the variety of products available at Ver-O-Peso, including fresh fish (sold both raw and cooked), fruits, craftsmanship, and Paraense culture. As negative aspects, the lack of hygiene (particularly evident through unpleasant odors) and the disorganization of the facilities were recurring issues in the market. However, it is worth noting that the majority of the reviews considered in this study were positive.

These informations are valuable for a better understanding of visitor behavior and can assist in making strategic decisions to improve the customer experience in the establishments in the smart or non-smart cities. Additionally, it was found that hygiene and sanitation issues are not exclusive to the market under review, as studies indicated that other cities in various regions of Brazil face similar challenges.

Therefore, this type of research is important so that managers of the Ver-O-Peso market and other similar establishments closely and continuously monitor customer reviews in an accurate manner and use sentiment analysis tools to identify potential improvements in management faster. Another strong reason to fix the problems listed in this research is that Belém-PA-Brazil receives a large number of visitors who frequents the Ver-O-Peso complex every year.

The use of AI and NLP techniques stands out to accurately interpreting large volumes of data, inferring valuable information for the management of public places, as described in this study. It became clear that data-driven insights empower smart cities to optimize services and address urban challenges more effectively.

The limitations of this research include analyzing only a single data source (TripAdvisor) and providing a computational application capable of enabling continuous monitoring of this type of data. These limitations can be addressed in future work.

# Turismo inteligente no complexo do Ver-O-Peso na cidade de Belém (Brasil): uma análise baseada em dados

## RESUMO

O complexo Ver-O-Peso é uma das atrações turísticas mais famosas da cidade de Belém, Pará, Brasil. É possível encontrar ali uma grande variedade de produtos, comidas típicas e bebidas da região amazônica, tornando-o um destino único e interessante. Por esses motivos, inúmeros visitantes frequentam o mercado todos os anos, e parte deles compartilha suas impressões na plataforma TripAdvisor. Análises orientadas por dados são essenciais para uma tomada de decisão mais inteligente, eficiente e responsiva em cidades inteligentes. O objetivo desta pesquisa foi identificar aspectos positivos e negativos do Ver-O-Peso com base em 3.749 avaliações extraídas do TripAdvisor. O IBM Watson foi utilizado para classificar o sentimento das avaliações. Por meio da metodologia CRISP-DM, constatou-se que 66,94%, 23,18% e 9,88% das avaliações eram positivas, negativas e neutras, respectivamente. Entre os aspectos positivos, muitos visitantes elogiaram a diversidade de produtos disponíveis para venda e a gastronomia (como peixe frito com açaí). Quanto aos aspectos negativos, vários turistas relataram problemas relacionados à higiene, infraestrutura e segurança. É válido analisar dados para identificar melhorias em pontos turísticos muito frequentados.

**PALAVRAS-CHAVE:** Gestão de cidades inteligentes. Conteúdo gerado pelo usuário. Gestão de atrações turísticas. TripAdvisor.

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