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Exploring public-private partnerships in Latin America and the Caribbean using topic modeling and sentiment analysis

Parcerias público-privadas em alguns países da América Latina e Caribe: aplicação de modelagem de tópicos e análise de sentimentos

Asociaciones público-privadas en algunos países de América Latina y el Caribe: aplicación de modelado temático y análisis de sentimiento

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Paulo Henrique dos Santos
Master in Production Engineering
Institution: Instituto Federal de Goiás
Address: Senador Canedo, Goiás, Brazil
E-mail: paulo.santos1@ifg.edu.br

Lucas Santos de Oliveira
Specialist in Applied Statistics
Institution: Instituto Federal de Brasília
Address: Brasília, Distrito Federal, Brazil
E-mail: lucas.oliveira4@estudante.ifb.edu.br

Márcio Dias de Lima
PhD in Computer Sciences
Institution: Instituto Federal de Goiás
Address: Goiânia, Goiás, Brazil
E-mail: marcio.lima@ifg.edu.br

Daniel Soares de Souza
Master in Public Management
Institution: Instituto Federal de Brasília
Address: Brasília, Distrito Federal, Brazil
E-mail: daniel.souza@ifb.edu.br

José Carlos Barros Silva
Master in High Education Sciences
Institution: Instituto Federal de Goiás
Address: Luziânia, Goiás, Brazil
E-mail: josecarlos.silva@ifg.edu.br

Geraldo Andrade de Oliveira
PhD in Electrical Engineering
Institution: Instituto Federal do Espírito Santo
Address: Presidente Kennedy, Espírito Santo, Brazil
E-mail: andrade.oliveira@ifes.edu.br

Pedro Carvalho Brom
Master in Statistics
Institution: Instituto Federal de Brasília
Address: Brasília, Distrito Federal, Brazil
E-mail: pedro.brom@ifb.edu.br

Alexandre Pereira Chahad
PhD in Physical Chemistry
Institution: Instituto Federal do Espírito Santo
Address: Vitória, Espírito Santo, Brazil
E-mail: alexandre.chahad@ifes.edu.br

Cassiomar Rodrigues Lopes
Master in Agrobusiness
Institution: Instituto Federal de Goiás
Address: Anápolis, Goiás, brasil
E-mail: cassiomar.lopes@ifg.edu.br

Maria das Graças Costa Nery da Silva
Master in Information Technology
Institution: Instituto Federal de Pernambuco
Address: Recife, Pernambuco, Brazil
E-mail: gnery2005@gmail.com

Karla de Aleluia Batista
PhD in Biological Sciences
Institution: Instituto Federal de Goiás
Address: Goiânia, Goiás, Brazil
E-mail: karla.batista@ifg.edu.br

ABSTRACT

Collaboration between the public and private sectors is crucial for supporting resource-constrained government budgets globally. Over the past two decades, studies have recorded significant advances in public-private partnerships (PPPs). However, PPPs in agribusiness within Latin America and the Caribbean (LAC) remain underexplored. This study analyzes the primary issues related to PPPs in agribusiness across selected countries and compares sentiments regarding these partnerships within the analyzed countries. Using text mining, topic modeling, and sentiment analysis, the study found that the main issues revolve around infrastructure, impacting trade, flow, and services in regional, national, and continental agribusiness and exports. While PPPs are seen as an innovative

approach to improving public services, sentiment analysis reveals that many countries express anger and disgust, primarily due to concerns about corruption and the state's inability to manage or play an effective role in these public policies. This study highlights that integrating topic and sentiment data offers a comprehensive view that can inform more effective public policies and development strategies for PPPs in agribusiness.

Keywords: Public Agreements. Voluntary Transfers. Sustainable Development. Innovation. Infrascope Index.

RESUMO

A colaboração entre setores público e privado desempenha um papel crucial no suporte a orçamentos governamentais com recursos limitados ou restritos em escala global. Durante as últimas duas décadas, estudos registram avanços significativos nas Parcerias Público-Privadas (PPP). No entanto, a PPP no agronegócio da América Latina e Caribe (ALC) ainda não foi compreendida. Diante disto, o objetivo deste estudo foi analisar os principais pontos envolvendo PPP voltada ao agronegócio em alguns países da ALC, além de comparar os sentimentos em relação ao tema nos países envolvidos na análise.
Este estudo fornece uma nova abordagem para esta análise, a mineração de textos, utilizando modelagem de tópicos e análise de sentimentos. Os resultados mostraram que os principais pontos estão ligados a infraestrutura estrutural dos países e da ALC como um todo, estas infraestruturas influenciam o comércio, fluxo e serviços do agronegócio regional, nacional e continental, além de afetar as exportações. A PPP insere-se como algo inovador na capacidade de melhoria dos serviços públicos, no entanto, ao realizar a análise de sentimentos, constatou-se que a maioria dos países possuem o sentimento de raiva e desgosto, pois a maioria dos comentários negativos concentram-se nas questões envolvendo corrupção e incapacidade do Estado de gerir ou realizar papel equalizador ativo nestas políticas públicas. O estudo implica que a integração dos dados de tópicos e sentimentos, proporcionam visão abrangente, que pode informar políticas públicas e estratégias de desenvolvimento mais eficazes voltadas para PPP no agronegócio.

Palavras-chave: Convênios Públicos. Transferências Voluntárias. Desenvolvimento Sustentável. Inovação. Índice Infrascope.

RESUMEN

La colaboración entre los sectores públicos y privado juega un papel crucial en el apoyo a los presupuestos gubernamentales con recursos limitados a escala global. Durante las últimas das décadas, los estudios registran avances significativos en materia de Asociaciones Público-Privadas (APP). Sin embargo, las APP en la agroindustria en América Latina y el Caribe (ALC) aún no se han entendido. Ante esto, el objetivo de este estudio fue analizar los principales puntos que involucran las APP dirigidas a los agronegocios en algunos países de ALC, además de comparar sentimientos sobre el tema en los países involucrados en el análisis. Este estudio proporciona un nuevo enfoque para este análisis, la minería de textos, utilizando modelado de temas y análisis de

sentimientos. Los resultados mostraron que los puntos principales están vinculados a la infraestructura estructural de los países y de ALC en su conjunto, estas infraestructuras influyen en el comercio, flujo y servicios de los agronegocios regionales, nacionales y continentales, además de afectar las exportaciones. El APP es visto como algo innovador en la capacidad de mejorar los servicios públicos, sin embargo, al realizar un análisis de sentimiento, se encontró que la mayoría de los países tienen un sentimiento de enojo y disgusto, ya que la mayoría de los comentarios negativos se concentran en temas que involucran corrupción y la incapacidad del Estado para gestionar o desempeñar un papel igualador activo en estas políticas públicas. El estudio implica que la integración de datos sobre temas y sentimientos proporciona una visión integral, que puede informar políticas públicas y estrategias de desarrollo más efectivas dirigidas a las APP en los agronegocios.

Palabras clave: Acuerdos Públicos. Transferencias Voluntarias. Desenvolvimiento Sustentable. Innovación. Índice de Infrascope.

1 INTRODUCTION

Public-private partnerships (PPPs) are long-term contracts between private parties and government entities to provide public goods or services (Munoz-Jofre et al., 2023). They have been promoted globally to address constrained public budgets (Nikolić et al., 2020). As a result, the private sector has become crucial in developing and operating infrastructure and services (Neto et al., 2019).

Approximately 60% of PPP contracts are executed in Europe, 15% in Asia, and 15% in North America and Latin America (LATAM) (Colasanti et al., 2019). The PPP models adopted in Europe have been implemented worldwide, particularly in Latin America and the Caribbean (LAC) (Colasanti et al., 2019). Brazil, one of the leading countries in PPP programs in the region, has been actively developing these partnerships (Neto et al., 2019). With a per capita arable land area of 0.242 hectares, LAC is often called “the Granary of the World in the 21st Century” (Zhang et al., 2023), p. 210).

Over the past 20 years, PPPs have yielded significant results, proving to be effective solutions for infrastructure investments. They enhance the efficiency of local public goods provision and help achieve public policy objectives in

environmental protection and social welfare. Additionally, PPPs can increase sustainability by promoting regional economic and social development, alleviating poverty, modernizing the agricultural industry, and expanding public services (Cao et al., 2024).

By combining the strengths of the public and private sectors, PPPs offer more efficient solutions and drive economic progress. They can adapt, develop, and often act as catalysts for necessary infrastructure changes (He & Yang, 2024). However, critics argue that PPPs are risky and costly ventures (Cao et al., 2024). The ongoing debate about the application of PPPs in LAC agribusiness underscores the urgent need for further research and empirical insights, particularly from the critics' perspectives (Neto et al., 2019).

1.1 PREVIOUS RESEARCH

Research on PPPs in LAC agribusiness is scarce, with studies practically nonexistent in major global databases. For example, Munoz-Jofre et al. (2023) developed an index based on critical success factors to assess the initial suitability of PPP projects for water and social resources in urban areas of LAC. However, their focus was limited to early-stage project feasibility, leaving a significant gap in understanding ongoing and completed projects. This highlights the urgent need for more comprehensive research in this area.

In contrast, Nikolić et al. (2020) investigated PPP road contracts awarded over 20 years in LAC, discovering that the region faced numerous financial setbacks without significant changes in the PPP market structure. However, their study primarily offered financial and judicial analyses with little practical guidance for new contracts.

Rodriguez Escobar (2019) analyzed the Social Innovation Experiences Project in LAC from 2002 to 2010, focusing on the social time of transnational PPPs in the early 21st century. Despite its historical perspective, the study does not address current conditions. Colasanti et al. (2019) provided a general analysis of PPPs before delving into their application in the health sector, offering a state-of-the-art review of relevant experiences in LAC. However, their findings are

specific to healthcare, limiting their broader applicability.

Guzman, Gomez, and Zamora (2016) examined the PPP model in Colombia and LAC to evaluate its potential for other projects and countries. Although innovative, their single-case study approach restricts the generalizability of their findings.

Estache et al. (2009), in higher-level publications from 15 years ago, used data from road and rail concessions in LAC to examine the likelihood of renegotiation based on award criteria. Similarly, Castro (2008) assessed public versus private models for managing water and sanitation services in Buenos Aires, Cochabamba, Cartagena de Indias, and Santiago de Chile. Lastly, Hartwich & Tola (2007) discussed the conditions for forming partnerships and compared these with real-life partnership experiences in LAC.

1.2 RESEARCH RELEVANCE

PPPs in agribusiness within LAC are rarely studied, and the level of interest among stakeholders remains unclear. To date, no large-scale studies have investigated the prevalence of opinions regarding the inclusion of agribusiness in PPPs. Although the importance of agribusiness in LAC has been acknowledged (Lazor et al., 2022), there is a lack of empirical investigations into the perspectives of critics and stakeholders on this topic.

In addition, a consistent empirical framework is needed to highlight the main concerns and viewpoints of critics and stakeholders regarding PPPs in agribusiness in the region. The absence of such studies shows the need for new research that supports academia and fills the existing gap. Thus, this research aims to understand the various perceptions of PPPs in agribusiness.

This article employs text mining techniques, specifically topic modeling and sentiment analysis, to analyze opinions from critics, experts, and news sources. The aim of this article is to identify and compare the main issues and sentiments surrounding PPPs in agribusiness in some LAC countries. The study uses the Infrascope index, developed by Economist Impact and the Inter-American Development Bank (IDB) (Banco Interamericano de Desenvolvimento,

2022), to select the primary countries in the region for text mining.

This is the first study to explore a substantial body of data related to PPPs in agribusiness in LAC, generating new insights into the perspectives of critics and stakeholders. The study's conclusions aim to guide academics in understanding the key empirical points discussed and provide structured insights to society and public officials. This holistic view is expected to facilitate the development of new research and practical applications in both the private and public sectors in the region.

However, the analysis presented here is based solely on data collected from the internet, specifically from searches conducted on the website "google.com.br" in the relevant country languages. This study does not encompass all available information, such as interviews and news items, and is limited to what was accessible through the specified database. Consequently, it cannot provide a comprehensive overview of all information released on the topic in each country.

1.3 ARTICLE STRUCTURE

The structure of this article is as follows: The first section provides the introduction. The second section discusses PPPs in LAC. The third section outlines the methodological approaches, followed by a section presenting the results obtained from applying text mining techniques. Finally, the fifth section offers the conclusions.

2 PUBLIC-PRIVATE PARTNERSHIPS IN LATIN AMERICA AND THE CARIBBEAN

PPPs represent long-term contracts between private parties and government entities to provide public goods or services. In these arrangements, the private party assumes significant risk and management responsibility, with remuneration typically tied to performance (Munoz-Jofre et al., 2023).

In LAC, PPPs emerged in the 1990s and have experienced moderate

growth, partly due to poor implementation in many cases. Between 2005 and 2015, investments through PPPs increased from USD 8 billion in 2005 to USD 39 billion in 2015. To date, more than a thousand projects covered by PPPs have been registered, with a special emphasis on the energy and transport sectors. Notably, there are 120 projects in Mexico, 505 projects in Brazil, and 93 projects in Chile (Pintor Pirzkall, 2020).

Countries in LAC exhibit clear differences in development levels, particularly in their economic, legal, technological, social, and environmental frameworks. These differences imply various challenges and potential solutions. Therefore, it is important to consider different management alternatives, including the PPP model with private-sector participation (Munoz-Jofre et al., 2023).

Mexico was the first Latin American country to implement PPPs. In Chile, the PPP model is known as the “concession system,” and during the 1990s, Peru carried out a large privatization program focused on PPP models. Colombia aims to launch PPP programs in education, highways, airports, and health. In Brazil, the first PPPs were introduced thanks to the so-called “Partnership Law,” which aims to regulate private investments in public projects from a collaboration perspective between the two sectors. In Argentina, a decree defines a PPP model based on the private sector’s duty concerning public interest activities, similar to those applied in Peru and Uruguay (Colasanti et al., 2019).

3 METHODOLOGY

Many researchers have utilized topic modeling and sentiment analysis in text mining across various fields (Corti et al., 2022; N. Kumar & Hanji, 2024; Movahedi Nia et al., 2023). This study employs topic modeling to organize a large collection of texts related to PPPs in agribusiness in LAC. It groups these texts into different themes, assigning a large mass of text to a collection of topics with different weights or probabilities without assuming any measured distance between topics (Lyu et al., 2021). Additionally, sentiment analysis calculates the sentiment polarity score for each country selected for research (Bibyan et al., 2023).

A significant advantage of using these two methods is that topic modeling finds latent semantic structures, while sentiment analysis can computationally identify or classify sentiments within these structures (Singh et al., 2019). In a recent study, Bibyan et al. (2023) argue that parameters are adjusted to fully accommodate the data corpus, using techniques such as maximum likelihood adjustment.

This study rejected primary data collection in favor of secondary data, which does not require the active participation of individuals. This approach offers the advantage of achieving a large volume of data in a short period of time. Secondary data is normally available (Correia et al., 2023), and topic modeling and sentiment analysis are increasingly being adopted by researchers for these reasons, among others (Sweidan et al., 2024; Thakur et al., 2024; Yun et al., 2023).

However, certain limitations are associated with using sentiment analysis. It faces issues of accuracy and bias (Chaturvedi et al., 2023), and ensuring generalization across languages and domains is challenging. Accurately interpreting sentiments is also difficult (Pulikonda et al., 2023). Similarly, topic modeling faces challenges in accurately extracting topics due to reduced contextual information in short texts (Cheng et al., 2023).

3.1 DATA COLLECTION

First, the Infrascope index, launched by Economist Impact and the Inter-American Development Bank (IDB) (Banco Interamericano de Desenvolvimento, 2022), was examined. This index is a comparative assessment tool that evaluates the capacity of countries to implement sustainable and efficient PPPs in key infrastructure sectors (Economist Impact, 2020).

The choice of countries was based on the overall score, which is the weighted sum (20%) of the following category scores: regulations and institutions; project preparation and sustainability; financing; risk management and contract monitoring; and performance and impact assessment (ex-post). Figure 1 presents the results.

Understanding that the Infrascope index has support to indicate the primary countries implementing PPPs in the region, we selected countries with a score equal to or greater than 60. Therefore, we captured texts from news, forums, social networks, reports, interviews, and other sources of information on the topic in each of the selected countries, in their respective languages, using the following Google search terms:

- In Spanish ("Asociaciones Público-Privadas" AND agri* AND "país correspondente" OR "Alianzas Público-Privadas" AND agri* AND "país correspondente");

Figure 1. Infrascope general index 2021/2022

Countries are scored from 0-100, where 100 = best

Rank	Country	Score / 100	Visualisation
1	Brazil	76,3	
2	Chile	75,3	
3	Uruguay	66,8	
4	Colombia	66,4	
5	Peru	63,4	
6	Panama	61,1	
7	Costa Rica	60,7	
8	El Salvador	58,1	
9	Guatemala	57,2	
10	Dominican Republic	57,1	
11	Mexico	56,9	
12	Jamaica	54,8	
13	Honduras	54,6	
14	Paraguay	53,4	
15	Ecuador	48,7	
16	Argentina	48,0	
17	Nicaragua	44,2	
18	Guyana	42,1	
19	Bahamas	37,0	
20	Haiti	27,5	
21	Trinidad and Tobago	25,3	
22	Bolivia	23,8	
23	Belize	21,8	
24	Barbados	18,0	
25	Venezuela	17,4	
26	Suriname	13,9	

Source: Economist Impact, 2024

- In Portuguese (“Parcerias Público-Privadas” AND agro* AND “país correspondente”).

Two researchers analyzed the research returns using different methods. Each selected specific content, and only the content chosen by both researchers was included in the final database. If a piece of content was chosen by one researcher but not the other, it was excluded from the database. In total, 532,088 words were captured, divided as follows: Brazil with 132,698 words, Chile with 39,742 words, Uruguay with 35,222 words, Colombia with 92,628 words, Peru with 75,825 words, Panama with 74,966 words, and Costa Rica with 81,007 words.

3.2 DATA PREPROCESSING

In this study, a computational workflow was implemented for cleaning and normalizing texts extracted from PDF documents using various R libraries: pdftools (Jeong et al., 2024), tm (Moro et al., 2023), fastText (Naboka-Krell, 2024), and data.table (Fairbanks, n.d.). The workflow aimed to optimize performance through parallel processing while building the database.

The initial text-cleaning stage involved removing special characters, punctuation, and numbers and normalizing text to lowercase letters. Regular expressions were used to eliminate prepositions and other common words that do not contribute to meaning analysis, ensuring data uniformity. Language identification for each text was performed using the pre-trained language identification model provided by the fastText package (Naboka-Krell, 2024). Subsequently, each text was structured using data.table (Fairbanks, n.d.), facilitating future manipulations and marking the original file location and detected language.

Finally, all processed data were consolidated into a single dataset, saved in RDS format for future use within the R environment, and in CSV format for external distribution and analysis. This pre-processing step enables more accurate and efficient analysis by minimizing noise and inconsistencies in the dataset, setting the stage for more complex linguistic and statistical analyses (Li et al., 2024).

3.3 TOPIC MODELING PROCEDURES

R libraries specialized for text processing and data manipulation were utilized in the textual analysis process. Among these libraries were data.table (Fairbanks, n.d.), tm (Moro et al., 2023), tokenizers (Kang et al., 2024), udpipe, ldatuning (Sipilä et al., 2024), digestion, text2vec, and Matrix (Hellín et al., 2023). The data were initially imported from the pre-processed file.

For the lemmatization stage, the Spanish-GSD model from udpipe (Sipilä et al., 2024) was employed, suitable for analyzing news forums on the internet, offering advantages in terms of interoperability and the variety of textual genres. To ensure computational efficiency during lemmatization, a cache system was implemented using a hash environment. This allowed only new words to be processed, while already computed lemmas were quickly retrieved from the cache. The process focused on retaining nouns, verbs, adjectives, and adverbs while excluding other grammatical classes such as determiners and prepositions to refine the analyzed content (Wahyuningsih et al., 2021). After the process, the lemmas of each document were combined into continuous texts, preparing the dataset for the vectorization stage.

In the vectorization stage, the lemmatized texts were transformed into a Document-Term Matrix (DTM) using the text2vec and Matrix libraries (Hellín et al., 2023), which facilitate the manipulation of sparse matrices. This DTM represents the frequency of each term in the documents and serves as a resource for topic modeling via Latent Dirichlet Allocation (LDA). The adequacy of the LDA model was assessed using metrics calculated by ldatuning. For these metrics, we followed the guidelines of Bhat et al. (2020), which include:

- Arun2010: Measures the difference between the distribution of words within topics and the words in the entire document collection. Lower values indicate a better fit, suggesting a more distinct distribution of words between topics.
- CaoJuan2009: Evaluates the coherence of topics based on the average density and variance. Higher values indicate more cohesive and well-defined topics.

- Griffiths2004: Calculates the log-likelihood of a model given the data. It is often used to compare models with different numbers of topics. Higher (or less negative) values are better.

3.4 SENTIMENT ANALYSIS PROCEDURES

Initially, we configured the development environment in R. This involved setting up the working directory and importing essential libraries for data manipulation (data.table), sentiment analysis (syuzhet), parallel computing (parallel), data visualization (ggplot2, fmsb), and color selection (RColorBrewer).

We utilized the United States National Research Council (NRC) Word-Emotion Association Dictionary, specifically adapted for Portuguese and Spanish. This enabled us to categorize emotions across multiple dimensions: anger, anticipation, disgust, fear, joy, sadness, surprise, trust, negative, and positive.

To conduct the Exploratory Data Analysis (EDA) of Sentiments, the processed data was imported and a summary analysis was performed. This involved evaluating metrics such as minimum, mean, median, maximum, standard deviation, and the coefficient of variation of sentiments by country. The data was then pivoted and grouped appropriately to facilitate a statistical summary.

The data underwent a normalization process to ensure a fair comparison, maintaining all metrics on the same scale. Each sentiment was individually normalized, centered around the minimum value, and scaled by the maximum value observed. The normalized data was then restructured for graphical visualization.

A graphic illustration, specifically a radar chart, was created to represent the distribution of sentiments. Additionally, the data was subjected to a non-parametric statistical test to identify possible significant differences, as the data did not meet the assumptions required for ANOVA. A Bonferroni correction was applied to control for type I errors resulting from multiple tests.

For the radar graph, statistics of the maximum, minimum, and median values per sentiment were computed. This data was used to construct a radar chart that depicted the median sentiment for each emotion, facilitating direct comparison. The graphics were saved in high-resolution PDF format using the ggsave

function.

4 RESULTS

4.1 TOPIC MODELING

For most places analyzed (Kim et al., 2021; Wu et al., 2022), four topics offer the best balance between different LDA evaluation metrics, providing good internal cohesion, separability, and model probability. This number of topics allows for a detailed and discriminated analysis of the subjects relevant to each region while maintaining the interpretability and relevance of the model. More details can be found in Table 1 and Figure 2.

Latent Dirichlet Allocation (LDA) was applied to eight documents, each representing a country: Chile, Colombia, Costa Rica, Panama, Peru, Uruguay, and Brazil, and one document covering LAC as a whole. The results were organized into main topics for each document based on the most frequent keywords (A. Kumar et al., 2024).

The topics in Brazil reveal an emphasis on agriculture, infrastructure, and investments. The main terms identified include “Brasil,” “inversiones,” “sector,” “agrícola,” “infrastructura,” and “servicios.” The recurring presence of the word “Brasil” suggests a national focus in discussions about innovation in agricultural and technological infrastructure.

Investing in public-private partnerships (PPPs) for the transition in energy production is essential, especially for economies like Brazil, which have unmet investment needs (Ahmad & Raza, 2020). Innovation through PPPs in the provision of public services reformulates organizational processes by creating new institutional arrangements to replace the exclusively state-owned provision model. This brings efficiency to public administration, allowing it to achieve results that conventional forms would not achieve (Costa & Ribeiro, 2019).

The document referring to Chile reveals an emphasis on water systems, the development of artificial intelligence, regulation, and security in the sector. Key terms identified include “sistemas,” “água,” “inteligência artificial,” and

"regulação." The recurring presence of the word "Chile" suggests a national focus in discussions of technological development and water resources in agribusiness. Considering regulations, institutions, maturity, investment, and financing climate, Chile is classified as a leader in LAC in the use of PPP. Analyzed texts about livestock and agricultural machinery include agricultural and livestock services originating from PPP (Mansilla & Vassallo, 2020).

In the analysis of the document on Colombia, the topics highlight development, public and private infrastructure, and the interaction between risks and public policies. The most frequent keywords include "desarrollo," "infraestructura," "público," and "privado," indicating a focus on applications and the integration of regional agribusiness in the country. In Colombia, public-private partnerships (PPPs) in state-funded schools (Cardona-Escobar et al., 2024) and investments in development and educational infrastructure are common. In the Colombian agribusiness sector, a strategic international cooperation project with Denmark began in 2016 to strengthen the safety and productivity of the Colombian swine chain, representing progress in the country's agricultural development (Rodríguez et al., 2023).

Costa Rica's topics show a strong focus on PPPs and infrastructure development, with an emphasis on national participation and the quality of public services. The main keywords include "infraestructura," "alianzas," "público-privadas," and "servicios," indicating the importance of partnerships for the development of infrastructure and government services aimed at the country's agribusiness. In Costa Rica, PPPs are particularly aimed at sustainable development (Herrero Amo & De Stefano, 2019), largely focused on agribusiness.

For Panama, the topics focus on development, services, and PPPs. Terms such as "desarrollo," "servicios," and "público" are recurrent, suggesting significant investment in technology and infrastructure to promote the development of services aimed at the agribusiness sector. Through innovative PPP approaches, Panama has developed a regional conservation park that reuses 100% of its treated wastewater, providing future opportunities for development in tourism and agri-food networks (Musser & Bomar, 2017).

Peru's topics indicate a focus on investments, projects, and regional development, with an emphasis on PPPs and infrastructure. Key keywords include "proyectos," "inversión," and "desarrollo," reflecting the country's efforts to promote growth through strategic investments in agribusiness innovation. Peru is one of the countries with the best macroeconomic indicators, showing significant growth over the last twenty years. Its main PPP contracts are classified into four groups: new construction, widening of lanes, road renovation and improvement, and road maintenance (Cisneros-Herrera et al., 2024). Currently, the main infrastructure works in Peru are carried out under the "agreement between governments" scheme. However, it is recognized that PPPs offer many advantages compared to this regime (Stucchi, 2023).

In Uruguay, the topics highlight water, investments, and development, particularly in the agricultural and infrastructure sectors. Frequent terms such as "água," "inversión," "desarrollo," and "infraestructura" indicate the country's priorities regarding sustainable development and the management of water resources for agribusiness growth. Public-private partnerships (PPPs) are recognized as a crucial tool for achieving global sustainability and are considered an innovative form of governance to address sustainability challenges (Herrero Amo & De Stefano, 2019). In Uruguay, PPPs create conditions for significant transformations in the structure and functioning of the state (Fuentes, 2017).

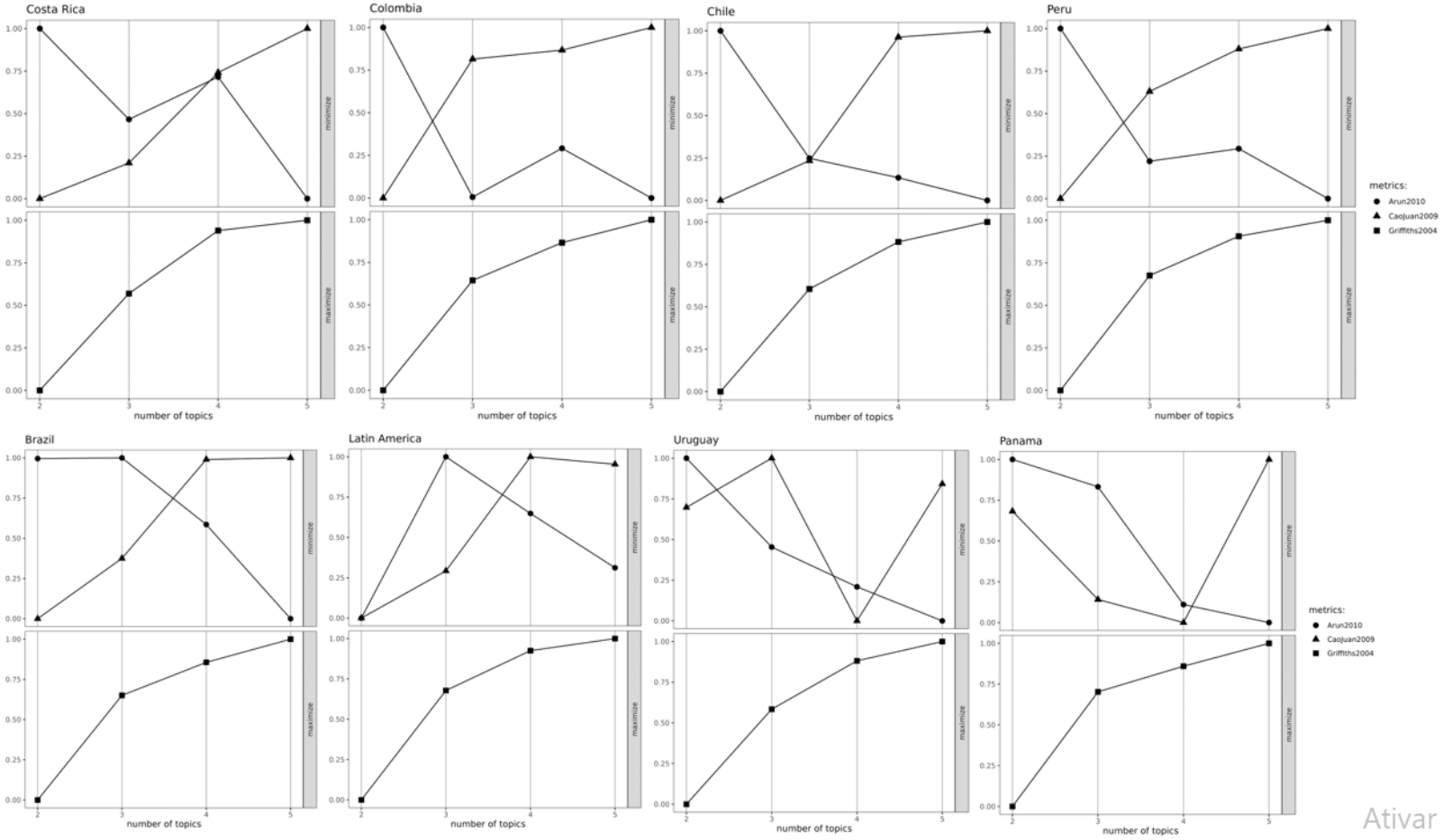
For LAC, the topics show a strong presence of terms related to development, public-private partnerships (PPP), and infrastructure investments. Keywords such as "desarrollo," "inversión," and "público-privadas" are common, suggesting a focus on innovation and partnerships for continental infrastructure development.

LAC continues to struggle with providing and maintaining the necessary infrastructure to unlock its economic potential (Neto et al., 2020). Partnerships are essential, particularly for service management, due to financial and infrastructure needs. Leveraging private companies' resources is crucial, especially in renewable energy, infrastructure, transport, and technologies. The debate on PPPs has been ongoing since the First World Summit on Sustainable Development in 2002 and Agenda 21, which brought together United Nations agencies,

governments, civil society, and private sector companies in sustainable development programs. Consequently, PPPs are vital for achieving the UN Sustainable Development Goals (Pintor Pirzkall, 2020). Selecting the best projects is a critical initiative (Munoz-Jofre et al., 2023).

Additionally, this comparative analysis shows that, although there is a common thread related to sustainable development and PPPs, each country has specific priorities reflecting their local needs and contexts.

Figure 2. Comparative metrics and definition of the number of topics



Source: the authors

Table 1. Consolidation of graphic evaluation

Country	Metric	Topics				Observations
		2	3	4	5	
LAC	Arun2010	High	Medium	Low	Low	Lowest value in 4 and 5 topics
	CaoJuan2009	Low	High	Medium	Low	Highest value in 3 topics
	Griffiths2004	Low	Medium	High	High	Highest value in 4 and 5 topics
Brazil	Arun2010	High	Medium	Low	Low	Lowest value in 4 and 5 topics
	CaoJuan2009	Low	High	Medium	High	Highest value in 3 and 5 topics
	Griffiths2004	Low	Medium	High	High	Highest value in 4 and 5 topics
Chile	Arun2010	High	Low	Medium	High	Most stable with 4 topics
	CaoJuan2009	Low	Medium	High	Medium	Highest value in 4 topics
	Griffiths2004	Low	High	Medium	High	Most stable with 3 and 5 topics
Colombia	Arun2010	High	Medium	Low	High	Lowest value in 4 topics
	CaoJuan2009	Low	Medium	High	Medium	Highest value in 4 topics
	Griffiths2004	Low	High	Medium	High	Most stable with 3 and 5 topics
Costa Rica	Arun2010	High	Medium	Low	Low	Lowest value in 4 and 5 topics
	CaoJuan2009	Low	High	Medium	Low	Highest value in 3 topics
	Griffiths2004	Low	Medium	High	High	Highest value in 4 and 5 topics
Panama	Arun2010	High	Medium	Low	High	Lowest value in 4 topics
	CaoJuan2009	Low	Medium	High	Medium	Highest value in 4 topics
	Griffiths2004	Low	High	Medium	High	Most stable with 3 and 5 topics
Peru	Arun2010	High	Medium	Low	High	Lowest value in 4 topics
	CaoJuan2009	Low	Medium	High	Medium	Highest value in 4 topics
	Griffiths2004	Low	High	Medium	High	Most stable with 3 and 5 topics
Uruguay	Arun2010	High	Medium	Low	High	Lowest value in 4 topics
	CaoJuan2009	Low	Medium	High	Medium	Highest value in 4 topics
	Griffiths2004	Low	High	Medium	High	Most stable with 3 and 5 topics

Source: the authors

4.2 SENTIMENT ANALYSIS

Sentiment analysis, also known as opinion mining or polarity classification, aims to examine and categorize textual content into different sentiments or emotions using various methodologies (Zammarchi et al., 2023). Table 2 presents a condensed examination of the results.

Table 2. Condensed examination of sentiment analysis results

Country	Mean	Standard deviation	Coef. Var. (%)	Median	Minimum	Maximum
LAC	378	240	63.4	290	149	880
Brazil	201	143	71.1	136	77	523
Chile	149	110	73.8	110	50	402
Colombia	209	146	69.7	155	80	536
Costa Rica	174	130	75.0	116	63	477
Panama	157	124	79.4	98.5	54	443
Peru	167	133	79.7	113	54	483
Uruguay	147	100	68.1	104	60	371

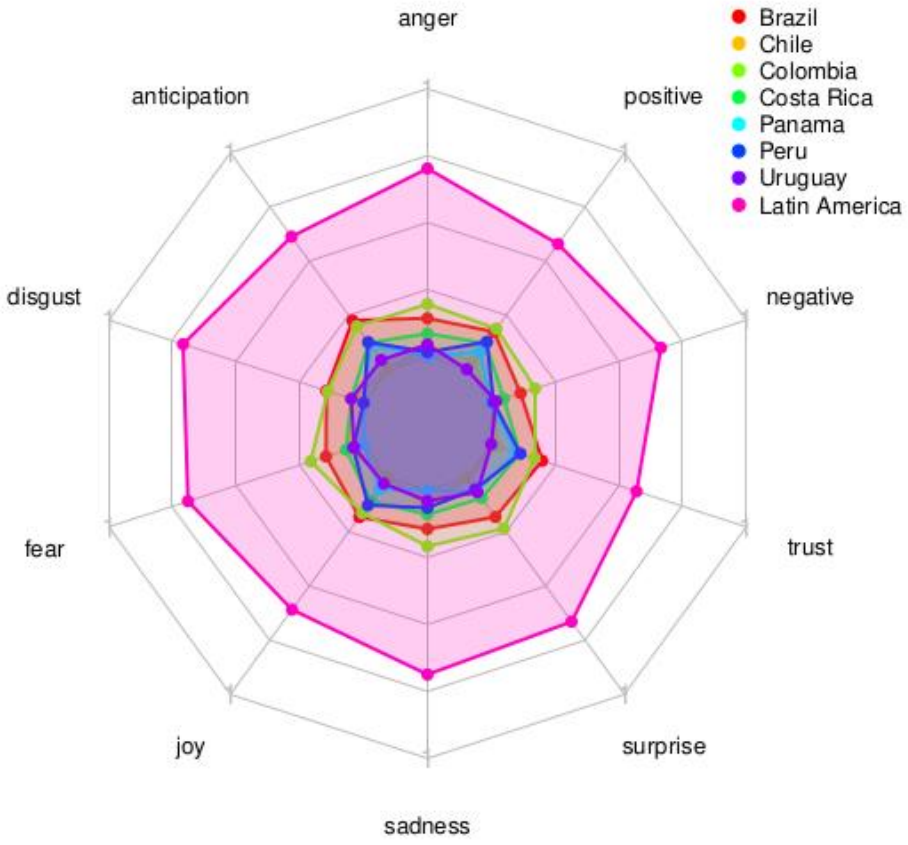
Source: the authors

LAC has an average sentiment score of 378, with a standard deviation of 240, indicating a high dispersion. The coefficient of variation is 63.4%, suggesting moderate variability, with scores ranging from 149 to 880. This intense and diverse emotional profile is illustrated by the magenta line on the radar chart (Figure 3), which shows high levels of anger and disgust along with significant positive emotions.

Comments such as “The Caribbean is very susceptible to Chinese money,” “There is a lot of corruption in Caribbean countries,” and “This tendency to accept investments from one country for a while and then move to another is part of an ‘extortion game’” emphasize this dichotomy of feelings. Additionally, remarks like “Latin America is not just Mexico, Brazil, and Argentina. We want to reach other countries with high-quality equipment and technological value, such as Ecuador or Bolivia” highlight the region’s diverse emotional landscape.

Brazil has an average sentiment score of 201 and a standard deviation of 143, showing moderate variability, with a coefficient of variation of 71.1%. The median score is 136, and the range of scores is from 77 to 523. Figure 3 indicates that Brazil presents a balanced distribution of emotions, with peaks in anger and disgust.

Figure 3. Comparison of emotional profile by region



Source: the authors

Comments highlighting these findings are: “The state government understands the need to expand the level of partnerships and bring the private sector to participate in projects in which the state does not have expertise,” “Brazil fell behind in terms of investment and now needs to reduce this gap,” “The federal government then established incentive programs to attract pioneering producers, who were bold and courageous. They took technology, money, and management, but they did not take the road, the railway, the warehouse, or the port,” and “In Brazil, private sector participation involves charging higher interest rates on PPP financing, as this partnership generally has a higher risk than the public administration alone. However, the problem facing society is the scarcity of public resources to implement the necessary infrastructure.”

Chile has a mean sentiment score of 149 and a standard deviation of 110, indicating less variability, but the coefficient of variation is 73.8%, suggesting high

relative variability. The median score is 110, and the range of scores is from 50 to 402. Figure 3 indicates that Chile has high levels of anger and disgust, while emotions such as joy and trust are less pronounced. Comments showing this perspective are: “Large agricultural economic groups, which require a large consumption of water, favor private business interests to the detriment of social needs” and “The industry has understood that each company solving its problems leads nowhere, and a spirit of association has been developing to face many of these problems, among others, talent, the communication aspect, or infrastructure. But there is a lack of better association with the state.”

Colombia has a higher mean sentiment score of 209, a standard deviation of 146, and a coefficient of variation of 69.7%, indicating moderate dispersion. The median score is 155, with scores ranging from 80 to 536. Colombia’s balanced emotional profile is evidenced by the green line in Figure 3, which shows no extreme spikes in emotions. Comments such as “They propose the participation of capital and private management within the scope of the public-private partnership (PPP) regime as an option for improving the prison situation and reducing growing crime. In other words, the private sector is seen as a panacea that solves different problems,” and “The adoption of efficient PPPs can guarantee food and nutritional security; strengthen family farming; fight poverty, with an emphasis on rural areas; and establish better intra-regional and domestic commercial channels” demonstrate this balanced profile.

Costa Rica and Panama present mean sentiment scores of 174 and 157, respectively, with similar standard deviations (130 and 124) and high coefficients of variation (75.0% and 79.4%). These locations show high relative variability, with medians of 116 and 98.5, respectively, and scores ranging from 63 to 477 in Costa Rica and 54 to 443 in Panama. Figure 3 reveals uniform emotional profiles in Costa Rica and a balanced profile with slight elevations in anger and disgust in Panama. Comments illustrating this include: “PPPs deserve forensic testing when there is sufficient evidence of possible fraud or acts of corruption,” “Public-private partnerships have funds to invest in agricultural infrastructure or services that benefit small farmers, especially for irrigated crops, contributing to the development of production by small farmers,” and “The state must assume a more

active role, in the form of public-private partnerships, to mobilize funds in the private sector to invest in agricultural infrastructure for small farmers."

Peru, with a mean sentiment score of 167, a standard deviation of 133, and a coefficient of variation of 79.7%, reflects a similar situation to Panama. The purple line in Figure 3 indicates an emotional profile with variations, highlighting anger and disgust. An illustrative comment about Peru is: "Preventing the participation of companies convicted or that have confessed guilt, incorporating anti-corruption clauses in contracts, and creating an integrity office, among others, are positive measures, but we feel that they will be insufficient to generate a significant impact on the transparency and competition of PPPs."

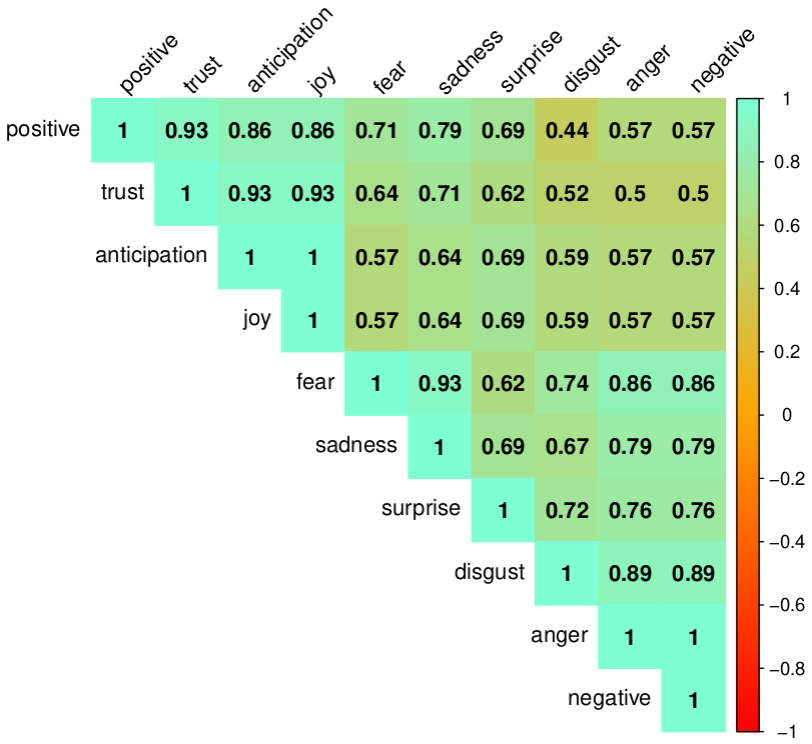
Uruguay has the lowest mean sentiment score of 147 and a standard deviation of 100, indicating less variability. The coefficient of variation is 68.1%, with a median of 104 and scores ranging from 60 to 371, confirming relatively low dispersion. Figure 3 shows a contained emotional profile, with smaller variations between emotions. Comments highlighting these findings include: "The Uruguayan government has established investment in infrastructure as a priority to guarantee the sustainability of growth and productivity levels in the Uruguayan economy," "Strengthening public-private partnerships and the capabilities of public institutions in mining countries ensures that environmental and social criteria are better taken into account, possibly avoiding unrest and interruptions in supply," and "The experience of PPPs in Uruguay allowed the sharing of resources, responsibilities, and risks in an association, where the public sector must define, investigate, train, audit, and certify health plans, and where the private sector must contribute by integrating itself into these actions."

4.3 CORRELOGRAM

The choice of Kendall's τ correlation for sentiment analysis is justified by the nature of the data, which consists of counts of emotions within each category. This data represents an ordinal scale where the order of values is significant, but the exact differences between values are not (Roy & Dutta, 2022). Consequently, Kendall's τ correlation is suitable for measuring the degree of agreement (Dasari

& Devarakonda, 2022), as it does not assume linearity. This makes it a more accurate method for assessing the strength and direction of relationships between different emotions within emotional clusters (Figure 4) and across regions (Figure 5).

Figure 4. Kendall's τ correlation matrix for emotional clusters

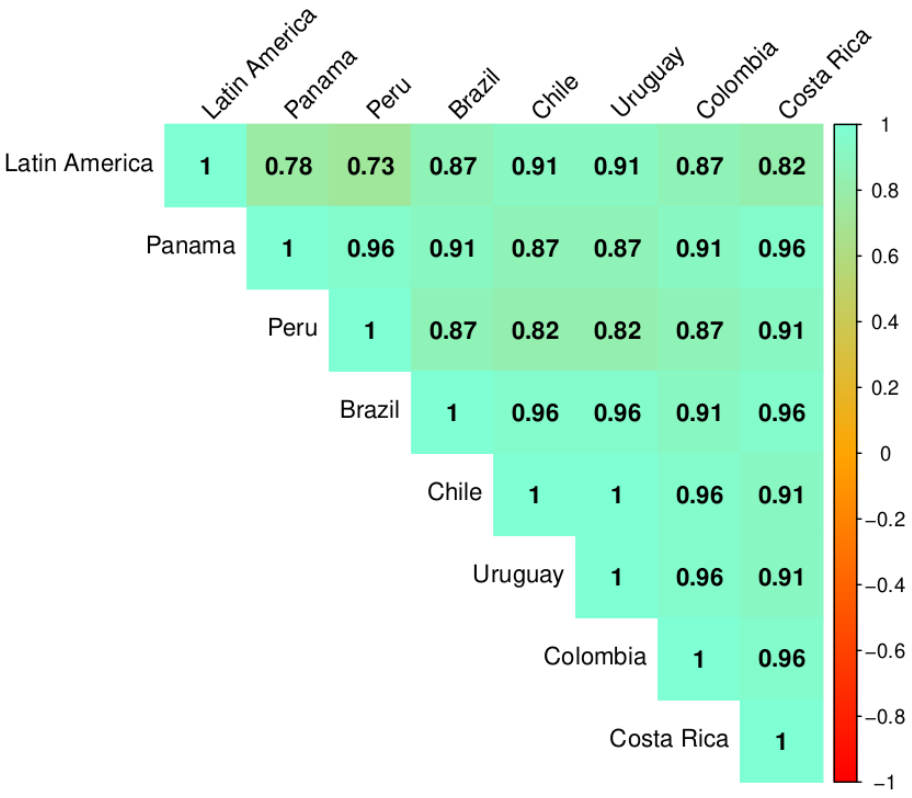


Source: the authors

In Figure 4, the following observations are made: **Strongly Positive Clusters** – joy and anticipation exhibit a very strong positive correlation (τ = 1.00), indicating that regions or texts showing high levels of joy also tend to have high levels of anticipation. Positive feelings and trust are also strongly correlated (τ = 0.93), suggesting that where there is a positive perception, trust is similarly high. **Negative Emotion Clusters** – anger, disgust, and negativity demonstrate an almost perfect correlation (τ = 0.89), meaning that high levels of anger are likely to be accompanied by significant amounts of disgust and other negative emotions. Fear and sadness are highly correlated (τ = 0.79), indicating that situations evoking fear are often associated with sadness. **Mixed Associations** – surprise shows a positive and moderate correlation with various emotions, such as disgust

(τ = 0.72) and joy (τ = 0.57).

Figure 5. Kendall's τ correlation matrix for regions



Source: the authors

This suggests that surprise can be associated with both positive emotions and anticipatory situations. Trust and sadness have a positive correlation (τ = 0.5), which may seem counterintuitive but might reflect complex emotional contexts where trust is sought in challenging situations.

In Figure 5, the following patterns emerge: **Strongly Positive Clusters** – Peru and Panama have a very strong positive correlation (τ = 0.96), implying that emotional patterns in Peru are very similar to those in Panama. Colombia and Chile exhibit a perfect correlation (τ = 1.00), showing highly similar emotional expressions in both regions. **Negative Emotion Clusters** – Costa Rica and Panama show an almost perfect correlation (τ = 0.96), indicating that emotional patterns in Costa Rica closely resemble those in Panama. Similarly, Colombia and Uruguay demonstrate a very strong correlation (τ = 0.96), suggesting that emotions in texts from Colombia are very similar to those from Uruguay. **Mixed**

Associations – The correlation between Peru and the overall context in LAC is moderate (τ = 0.73), indicating some alignment with average emotions in the region but not a perfect match. Panama's correlation with LAC is moderate (τ = 0.78), suggesting similarities but also notable differences in emotional expressions.

These results emphasize the role of sustainable development and PPPs, highlighting that each country's priorities reflect its unique needs and context. The observed high emotional variability among countries, with strong positive or negative correlations between different emotions, underscores the complexity of challenges and opportunities in LAC. This diversity stresses the importance of tailored approaches to regional development. Integrating topic and sentiment data offers a comprehensive view, supporting more effective public policies and development strategies.

5 CONCLUSION

This study analyzed the key aspects of PPPs aimed at agribusiness in selected countries in LAC, comparing sentiments toward the topic across these nations. The main points identified are linked to the infrastructure of the countries and the region as a whole, which influence trade, flow, and services in regional, national, and continental agribusiness and, consequently, exports.

The study also addressed the potential of PPPs to boost agricultural production. Due to the expertise and involvement of the private sector, PPPs are seen as innovative ways to improve public services. Uruguay stood out by highlighting the use of PPPs for sustainable development, emphasizing their role in promoting public policies focused on social and environmental issues.

However, sentiment analysis revealed that many countries feel anger and disgust toward PPPs, primarily due to concerns about corruption and the state's inability to manage or play an equalizing role in public policies. Panama, Peru, and Colombia exhibited balanced emotions, while Brazil and Chile showed high levels of anger and disgust. These results indicate the complex obstacles and possibilities faced by LAC, underscoring the need for personalized strategies for

regional progress.

The findings are significant from four perspectives. From the theoretical point of view, they contribute by filling gaps related to PPPs in LAC agribusiness. From the managerial perspective, they offer a basis for managers involved in public-private agreements to understand society's view through the identified topics and sentiments. The findings contributed from the perspective of regional development by highlighting the need for mechanisms to develop PPPs based on local solutions. Finally, from the viewpoint of public management, they provide relevant information for developing more effective PPP projects tailored to local needs.

The strength of this study lies in integrating topic and sentiment data, offering a comprehensive view that can inform more effective public policies and development strategies aimed at PPPs in agribusiness. Methodologically, using topic modeling and sentiment analysis in text mining is promising as it overcomes several limitations of traditional questionnaires.

However, this study has limitations. The libraries used cannot properly detect sarcasm, potentially misclassifying certain comments during sentiment analysis. Future studies should employ techniques to address this limitation. Additionally, data were collected from various open internet platforms without a specific focus, providing a broad view but potentially lacking accuracy compared to specialized platforms. Future research should analyze data from pages dedicated to PPPs to ensure robust and comprehensive analysis.

In terms of research limitations, this study is subject to two weaknesses in its development. However, it should be noted that the study makes a significant contribution to the understanding of topics and sentiments related to PPPs in LAC agribusiness. Firstly, the sentiment analysis libraries utilized are unable to accurately detect sarcasm, which may result in the misclassification of some comments. This may have affected the precision of the analysis and, consequently, the interpretation of the sentiments expressed. Furthermore, it is important to acknowledge that the data was gathered from a multitude of open internet platforms without a specific focus, providing a comprehensive overview but potentially less precise compared to data from specialized platforms.

To address the aforementioned limitations, future research should aim to mitigate the weaknesses of this study. To this end, future studies should consider integrating advanced natural language processing techniques that address the aforementioned limitation and improve the accuracy of sentimental analysis. Furthermore, data collection should be targeted to pages and platforms dedicated to PPPs in order to obtain a more accurate and in-depth analysis. This will facilitate a more comprehensive and precise examination, thereby enabling a more detailed comprehension of the dynamics and challenges confronted by these partnerships within the agricultural sector.

With regard to academic contributions, the study identifies the limitations of the sentiment analysis techniques employed and underscores the necessity for more specialized data, thereby highlighting critical areas for the advancement of more sophisticated research methods. From this perspective, the recommendations for examining the impact of specific technologies and practices on agricultural productivity and sustainability provide a framework for subsequent research that can contribute to theoretical and practical advancements in the field of PPPs and agribusiness.

For society at large, the results of this research offer insights that can help improve the effectiveness of PPPs in the agricultural sector. It is important to acknowledge that an understanding of the impact of investments in technology and sustainable practices on productivity and sustainability can inform the development of more effective public policies and investment strategies, which in turn can benefit farmers and local communities. The findings of this study can assist policymakers in establishing more conducive conditions for the advancement and implementation of PPPs, thereby fostering innovation and efficiency within the agricultural sector.

Despite these limitations, this research contributes to understanding the topics and sentiments related to PPPs in LAC agribusiness, providing a foundation for future research. Key insights for future research include investigating how investments in agricultural technology boost productivity and efficiency in Brazil's agricultural sector; exploring how Chile uses artificial intelligence to optimize irrigation and water resource management; analyzing

improvements in public and private infrastructure that facilitate Colombia's agricultural exports; studying successful PPPs promoting sustainable agricultural practices in Uruguay; evaluating the impact of applications and technologies on increasing agricultural efficiency and productivity in Panama; investigating the results of foreign investments in Peru's agribusiness sector; analyzing Costa Rica's water management policies contributing to agribusiness sustainability; and studying regional integration of agricultural markets in LAC and its effect on global competitiveness.

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