Artificial intelligence as support for decision-making in the public policy agenda of the city of Bogotá

Inteligencia artificial como apoyo de toma de decisiones en la agenda de políticas públicas de la ciudad de Bogotá

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Abstract: Science, technology, and innovation are crucial in addressing the most pressing contemporary issues. However, Colombia lags behind in the development of E-Government, a key variable in strengthening the relationship between society and the state. To close this gap, a model for creating public policy agendas was developed using Twitter, artificial intelligence algorithms, and Big Data collection techniques. In the metropolitan region of Bogotá in 2022, real-time tweets were collected to identify key themes and create a public policy agenda that reflected the population's needs. Data analysis tools were applied, and a bipartite graph was used to visualize the relationships between the selected themes. The final proposed agenda represents an important tool for promoting citizen participation in decision-making and advancing the construction of a fairer and more equitable society. It is noteworthy that the proposed model was able to capture 40,000 tweets published in real-time in the metropolitan region of Bogotá at low cost and high flexibility, demonstrating its effectiveness in analyzing large volumes of data.

Keywords: Public Policies, Twitter, E-Government, Data, Citizen Participation and Big Data

Resumen: La ciencia, la tecnología y la innovación son cruciales para abordar los problemas contemporáneos más apremiantes. Sin embargo, Colombia se encuentra atrasada en el desarrollo del E-Gobierno, una variable clave para fortalecer las relaciones entre la sociedad y el Estado. Para cerrar esta brecha, se desarrolló un modelo de creación de agendas de políticas públicas que utiliza Twitter, algoritmos de inteligencia artificial y técnicas de recolección de datos Big Data. En la región metropolitana de Bogotá, en 2022, se recopilaron tweets en tiempo real para identificar temas clave y crear una agenda de políticas públicas que reflejara las necesidades de la población. Se aplicaron herramientas de análisis de datos y se utilizó un grafo bipartito para visualizar las relaciones entre las temáticas seleccionadas. La propuesta de agenda final representa una herramienta importante para fomentar la participación ciudadana en la toma de decisiones y avanzar en

la construcción de una sociedad más justa y equitativa. Cabe destacar que el modelo propuesto logró capturar 40.000 tweets publicados en la región metropolitana de Bogotá en tiempo real, a bajo costo y alta flexibilidad, lo que demuestra su efectividad en el análisis de grandes volúmenes de datos.

Palabras clave: Políticas Públicas, Twitter, E-Gobierno, Datos, Participación Ciudadana y Big Data

1. INTRODUCTION

From the 2020s to the 2030s, humanity has focused on meeting the goals of the 2030 Agenda for Sustainable Development. The implementation of Artificial Intelligence (AI) in supporting decision-making for public policy in the city of Bogotá has emerged as an opportunity to overcome current challenges and achieve effective and sustainable governance. "Science, technology, and innovation have the potential to overcome some of the most complex challenges facing the world today. Digitalization in the public sector provides opportunities to support the achievement of the 2030 Agenda and the Sustainable Development Goals (SDGs)" [1]. A good implementation and expansion of E-Government alongside governance provide elements for effective, accountable, and inclusive institutions, as requested in Sustainable Development Goal number 16 "Promote just, peaceful, and inclusive societies"; similarly, any improvements in this index locally constitute an improvement in the sustainability of cities and communities, pursuing Goal number 11 "Make cities more inclusive, safe, resilient, and sustainable".

The E-Government Development Index (EGDI), calculated by the United Nations, is used as a measure to assess the implementation and impact of E-Government. Globally, the average EGDI has increased from 0.55 in 2018 to 0.60 in 2020, demonstrating a clear trend of improvement. In the American continent, Colombia is in the High quartile and HV sub-quartile, ranking tenth regionally and 67th globally. However, there is room for improvement and advancement towards the Very High quartile; the implementation of electronic governments is a high-impact factor in social development [2].

E-Government and effective governance are crucial for building cities adapted to the present. The strategic use of data in the governance of a nation and the development of participatory public policies are fundamental to achieve positive results [3].

Public policies are the materialization of society's desires and ideas and express the objectives that seek to build collective well-being [4]. Policies provide guidance for implementation and evidence the purpose of state intervention. Additionally, responsibilities and resources are distributed among the various actors in society. In this context, Twitter offers novel ways of Government-Citizen interaction [5]. The design of a Twitter data-based model for public policy creation in the Bogotá Metropolitan Region is proposed since it is one of the largest sources of human-generated data collection [6]. Social networks, like Twitter, and the implementation of new digital technologies, such as artificial intelligence and big data, play a significant role in the social and economic construction of cities, often in real-time, thus generating more value [7].

The development of new digital technologies has proven to be relevant in the global economy. According to the communication from the European Commission to the European Parliament, the European Council, the European Economic and Social Committee, and the Committee of the Regions [8], with an estimated 643.000 billion euros in 2020 and a forecast of worldwide spending on artificial intelligence and related technologies of over 432.800 billion dollars in 2022.

The implementation of artificial intelligence in supporting decision-making for public policy in Bogotá is an opportunity to enhance governance; the responsibility of public authorities aims to satisfy some vision of the "public good," and this necessarily involves the participation of multiple actors [9]. Building sustainable cities and harnessing the potential of new digital technologies for the benefit of society.

2. METODOLOGIA

The study was conducted with the aim of analyzing tweets emitted in the Bogotá D.C. metropolitan region for the development of public policies. A non-experimental cross-sectional design was used

to observe phenomena in their natural context and analyze them. Additionally, a mixed research approach was applied, which includes the collection and analysis of both quantitative and qualitative data, in order to obtain a deeper understanding of the phenomenon.

The Twitter API and the Tweepy library in Python were used to access tweets from users in the Bogotá D.C. metropolitan region. Geographical coordinates were established to delimit the study area, and a simple random probabilistic method was applied to select a representative sample of tweets.

The analysis model consisted of three main stages: identification of key variables, parameterization of the model, and proposal of an agenda in public policy, "an element through which certain problems or issues draw the serious and active attention of the government as potential matters of public policy" [10]. In the first stage, relevant variables for the analysis were determined, in the second stage, programming and statistical variables were designed, and in the final stage, a graph analysis was performed to obtain relevant information.

Tweets were cleaned by removing keywords, emojis, and other irrelevant elements. Clustering was used to classify data into groups, and the model was statistically validated to assess its effectiveness.

Fig. 1. Methodological Research Model.
Source: *own elaboration.*

The study employed Twitter data to analyze the perception of citizens in Bogotá D.C. and propose a public policy agenda. Various techniques and methodologies, such as non-experimental design, mixed approach, clustering, and statistical validation, were applied to process and analyze the data efficiently and derive useful insights.

3. MODEL

After conducting a comprehensive analysis of the current state of using social media for public policy creation, with a specific focus on Twitter, as it is the platform that offers the greatest potential for such studies [11], and after obtaining the methodological model, the application model was created.

The application model consists of three stages developed sequentially. The first stage is aimed at identifying key factors for the successful development of the module. The second stage involves how data is taken from random samples, meeting minimum statistical quality indicators, through APIs developed for this purpose, implemented from Python, carrying out ETL processes and visualization. Lastly, the third stage involves exploratory analysis and visualization to ultimately create the public policy agenda.

3.1. Identification of Key Variables

In the first stage of the model, the most relevant variables were selected: the geographical space Bogotá D.C, the temporal space year 2022, and the technological platform for development. A study was conducted that had sufficient theoretical and practical support, ultimately identifying these variables as the cornerstone, ensuring information with completeness, credibility, precision, consistency, and interpretability.
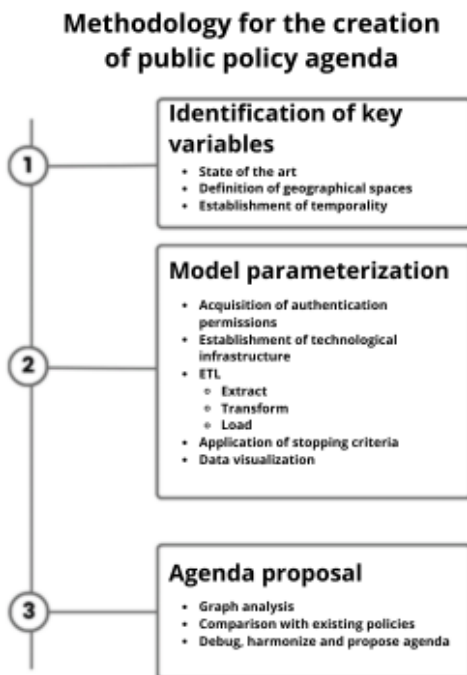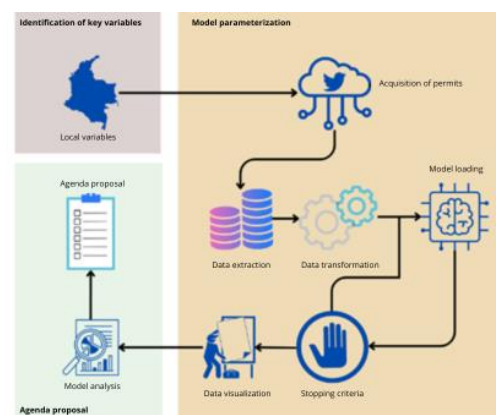

Fig. 2. Application Model for Public Policy Agenda Supported by Artificial Intelligence. ***Source:*** *own elaboration.*

The selected geographical space is Bogotá, given its status as the most important city in Colombia, with the potential for high impact on social and political dynamics and the implementation of new technologies. Additionally, its large population makes the information extraction stage easier.

Regarding the temporal dimension, this project was carried out in the year 2022, as it is an important year in terms of public policies due to the arrival of the new president to the country and the renewal of national political entities. It is also a pre-electoral year for regional elections in Colombia, as indicated by [12]. The information required should thus result from an inquiry into the causes and consequences and dynamics of politics.

Finally, the size of the representative sample for a known finite population was determined, based on a validity probability of 70% for the tweets according to [13] and a reliability of 95%, resulting in 38,415 tweets mined from the social network. Additionally, the organization of the collected data in CSV format for local storage was established, facilitating its manipulation and exportation to other systems, in line with the study's needs in terms of time, space, and population.

3.2. Parameterization of the model

The process of programming the algorithms was broken down into three activities: extraction, cleaning, and application of artificial intelligence. For this purpose, open-source programming languages Python and R were used, as they have specialized libraries for data mining and artificial intelligence applications. It is worth highlighting the choice of these programming languages due to their ability to work with large amounts of data and their flexibility to adapt to different needs.

Firstly, the algorithm for extracting data from Twitter was created, obtaining developer credentials beforehand through a request to Twitter, focused on research and educational objectives.

Subsequently, access keys for the project and the connection with Python in Google Colab were configured. The code development process included creating a class with predefined objects to establish the connection, extract tweets, and handle errors. The access keys were used in Python to connect to the Twitter APIs, using auth 2.0 protocol. Parameters were added to continue the task upon reaching the tweet limit, and the collection of tweets was defined according to specific accounts, keywords, or geographical locations, such as the Bogotá metropolitan region with latitude and longitude coordinates (-74.3895486797 E, 4.3996948487 N, -73.8994847983 E, 5.0859738645 N).

Randomness was considered in the selection of tweets in case of excessive flow before finalizing this development stage.

During the data transformation stage, approximately 40,000 mined tweets were cleaned using Python libraries such as pandas, numpy, and nltk, providing a representative sample of the studied population.

This phase included the removal of elements such as URLs, emojis, special characters, punctuation marks, and numbers, aiming to improve the data quality. This process resulted in obtaining an Excel file with the same number of tweets but cleansed, which is a fundamental element for subsequent analysis. Additionally, quantitative methods were applied to assess the effectiveness of data cleaning, where a significant reduction in the number of elements was observed, highlighting the rigor of the process and the quality of the resulting data.

Subsequently, using R and various specialized libraries, the cleansed tweets were analyzed in-depth, removing words that lack value for analysis such as natural language expressions, articles, abbreviations, among others. The "textstat_simil" function was applied for data vectorization and the calculation of similarity matrices, providing clear numerical results on the relationship between different tweets. Additionally, the Hopkins statistic was used to evaluate the feasibility of data clustering, obtaining a low significance value (H=0.03682534), indicating a high clustering tendency.

It is important to note that the clustering algorithm used is unsupervised, and after its application, a total of nine different clusters were obtained. This rigorous methodology, supported by concrete numerical results, establishes a solid foundation for data analysis and interpretation, thus allowing the generation of robust and relevant conclusions for the study at hand.
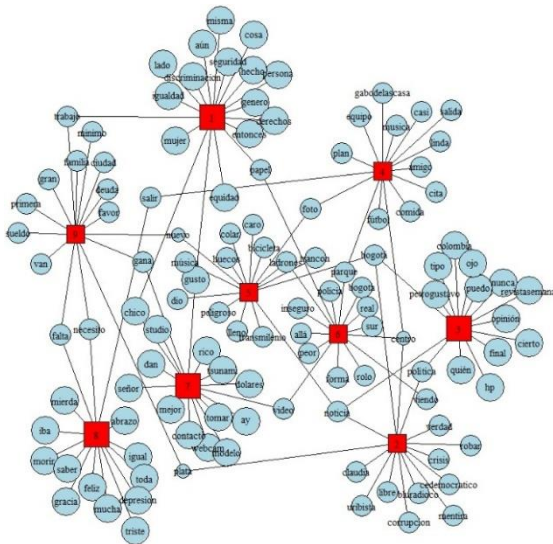
***Fig. 3.** Bipartite Graph Resulting from Tweets from the Bogotá Metropolitan Region as Input for Public Policy Construction.*
***Source:** Own elaboration.*

The process involved data extraction from Twitter using a Python algorithm, data cleaning and transformation, and finally data analysis and generation of a bipartite graph using the R programming language. The final result provided valuable information for formulating public policies based on the topics identified in the tweets.

4. PROPOSAL OF AGENDA

An agenda in public policies has been established through the application of the proposed analysis methodology for the third and final activity. In this process, general groups were identified, which were marked and described in the graph presented previously, along with the relationships between them. To develop a comprehensive proposal for a public policy agenda, an exhaustive analysis of the graph is required, which will be carried out qualitatively by the researcher. [14] recognizes that the analyst's role is to investigate the dynamic conditions and social and political processes involved in problem construction and its inscription on the government agenda.

The following is the methodology that allowed for this analysis to be completed comprehensively, thus generating a proposal for an agenda in line with the existing agenda
.
Identify the generated groups, highlighted for being centered in a red box for this case.

1. Identify the words that are connected to the groups through an arc to the main node and have no further connected arcs.
2. Assign a thematic to each of the groups that represent them.
3. Generate a thematic-group guideline list.
4. Observe through which concepts the groups are related, which will be with the words that have more than one connected arc.
5. Update the thematic-group table.
6. Perform comparison with the inventory of public policies and the context generated by the analysis of each of the words.
7. Refine and propose a public policy agenda.

The methodology was systematically applied to each group, starting from group 1 to group 9. Each group was analyzed in terms of associated words, assignment of themes, and relationships with other groups through connected words.

In group 1, words such as woman, equality, discrimination, gender, rights, and security were identified. These words were related to the theme of women and gender equity.

In group 2, words such as free, corruption, lie, as well as names of important political figures, were found. Together with group 3, which included words like end, certain, opinion, Colombia, and names of Colombian politicians, it was decided to assign them the theme of political education and communications. This is due to the frequent use of Twitter, which has more than 330 million monthly active users creating over 500 million tweets per month, resulting in more than 200 billion tweets in a year [15], a social network with high national impact, in the political and communications context of the country.

Group 4, related to recreation and the use of free time, included words such as sport, music, park, family, game, and tourism. A relationship with the consumption of psychoactive substances and the prevention of their use was identified.

Group 5 was related to mobility and contained words such as transportation, traffic, congestion, accidents, and thieves. The relationship between mobility and security was highlighted due to the presence of thieves in public transportation.

Group 6, related to security, included words such as violence, crime, and theft. The importance of news and communications in distributing information about traffic and security in the city was evident.

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Group 7, related to sexual education and reproductive rights through technological platforms, presented words such as education, video, pregnancy, information, and technology. The relationship between sexual education and technology as a means to access information and resources related to reproductive rights was highlighted.

Group 8 focused on mental health and included words such as stress, anxiety, depression, therapy, and support. No clear relationships with other groups were identified at this stage of the análisis
.
Group 9, related to employability, included words such as work, employment, unemployment, skills, and training. A relationship with the theme of women and gender equity through work and employability was identified.

Although significant connections were identified and established between several groups, some groups did not present clear connections with others at this stage of the analysis. This indicates the need for further analysis and consideration of new sources of information for future stages of the methodology. The thematic-group list was as follows.

Table 1: Final thematic-group table

GROUP	THEME
1	Women and Gender Equity
2	Political Education and Communications
3	Political Education and Communications
4	Recreation and Use of Free Time
5	Mobility
6	Security
7	Sexual Education and Reproductive Rights through Technological Platforms
8	Mental Health
9	Employability
(1 - 9)	Women's inclusion in the labor market
(2,3 - 4)	Recovery of downtown Bogotá as a recreational space
(2,3 – 5)	Use of information and communication technologies to improve mobility
(4 – 6)	Recovery of public parks as spaces for well-being
(4 – 8)	Use of free time as a suicide prevention tool
(5 – 6)	Strengthening security in public transportation

Source: Own elaboration

The processes of creating public policy must be harmonized with those already in place. To achieve this, a validation of the proposed groups will be conducted by comparing them with the inventory of implemented public policies offered by the District of Bogotá. This comparison aims to harmonize existing policies and identify which proposals will be entirely new.

The final proposal for the agenda of public policies will analyze the results of harmonization with the existing policies. The classification was done based on the existence and completeness of district public policies. For the analysis, six (6) thematic areas were identified that already have their policies, and their general objectives align with the analyses conducted. Therefore, these areas will be discarded as proposals since they do not add value to what already exists.

Table 2: Comparative Table with Existing Public Policies

PROPOSAL	DISTRICT PUBLIC POLICY
Women and Gender Equity	Public Policy for Women and Gender Equity in the Capital District
Political Education and Communications	Public Policy for Transparency, Integrity, and Zero Tolerance for Corruption in Bogotá Public Policy for Incident Participation in the Capital District
Recreation and Leisure Time Use	Public Policy for Sports, Recreation, Physical Activity, Parks, and Venues for Bogotá District Public Policy on Public Space
Security	District Public Policy on Coexistence and Citizen Security
Mental Health	District Mental Health Policy 2015-2025
Employability	District Public Policy on Cultural and Creative Economy District Policy on Productivity, Competitiveness, and Socioeconomic Development of Bogotá, D.C. 2011-2038 (Includes Public Policy on Financing and Democratization of Credit in Bogotá, D.C.) Public Policy for Decent and Dignified Work in Bogotá, D.C.

Source: Own elaboration

On Twitter, spontaneity and immediacy prevail, which can promote a fluid exchange of conversation and political debate [16]. Subsequently, the proposed themes that do not have any public policy representation were analyzed. In all cases, the proposed themes that did not have an already implemented public policy were the results of the union of groups carried out in step five of the methodology. This indicates that the holistic vision being sought is one of the shortcomings of the existing policies. Due to the evident impact, specific

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public policies will need to be created for these themes.

Finally, three (3) themes were found that have related policies, but their general objectives do not fully align with the analyzed needs. A review was conducted for each of the proposals and the general objectives of the policies that represent them or have a similar theme.

Once the updated and harmonized list was refined, a total of eight (8) themes remained for the proposed public policy agenda:

- Mobility.
- Sexual Education and Reproductive Rights through technological platforms.
- Inclusion of women in the labor market.
- Recovery of downtown Bogotá as a recreational space.
- Use of information and communication technologies to improve mobility.
- Recovery of public parks as spaces for well-being.
- Use of free time as a tool for suicide prevention.
- Strengthening security in public transportation.

This was the final proposal for the inclusion of themes for the construction of the public policy agenda, highlighting that the design, implementation, and evaluation of these policies are beyond the scope of this research.

In summary, the proposed methodology provides a systematic and comprehensive approach to analyzing and creating a public policy agenda. Through the identification of thematic groups, the assignment of themes, the observation of relationships between groups, and the comparison with the existing inventory of public policies, the aim is to achieve a holistic vision and a coherent agenda proposal that addresses the current challenges and needs of the city.

5. CONCLUSIONS

The research determined that, although the government is defined as "the macro social institution responsible for managing development, concentrating and distributing political power, and guiding social decision-making" [17], the creation of public policy agendas is predominantly driven by the humanities. New technologies have provided opportunities to include citizens in political decision-making. Through the algorithms used in this research, some of the existing barriers were overcome, such as the public's disinterest in active political participation and the inclusion of marginalized and vulnerable sectors of society that lack the capacity to bring their problems and needs to the political sphere.

Advantages found in this model include the short time required for development and the significant impacts it can generate, the low cost of data processing operations, the inclusion of new technologies based on open-source software, and its capacity for continuous development. Additionally, its easy application and adaptability allow any decision-maker to use it. However, some disadvantages were also identified, such as susceptibility to trends, necessitating special care in the mining windows, computational needs for large-scale data processing, the number of Twitter users in the study region, the error range of the API used, and the necessity for specific territorial knowledge for software re-parameterization.

The development and implementation of the model yielded the expected results, concluding that it is indeed a highly useful support tool. Nonetheless, the model has ample room for improvement and a wide application field. From the process of refining the model, it is concluded that, thanks to its flexibility, it is applicable in other cities in the country and even worldwide, creating reproducible processes for subsequent application in different scenarios, addressing a need in the scientific community [18]. Three important variables to consider are: the population of the geographical space, the use of Twitter in the region, and the independent realities and dynamics of the study region, understood as specific territorial knowledge.

The developed research aims for such national advancements to positively impact the measurement of the E-Government Development Index (EGDI). In the online services sub-index, which seeks to expand interaction between citizens and the government through electronic services, according to the Ministry of Information and Communications Technology on its Digital Government website, it highlights that this sub-index "drives" the other two sub-indices [19]. However, this only references the significant impact of digitizing procedures such as issuing duplicates of citizenship cards, military cards, social security affiliation, etc. Policymakers and decision-makers, described as: "Those with analytical skills, especially with experience in domains related to specific sectors (such as health or education); capable of assisting in policy analysis to

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support public policy formulation (from planning to implementation and evaluation)" [20], are currently not emphasizing how citizens can be involved in decision-making through technological means. This is where there is a significant opportunity for improvement in E-Government. Therefore, the way of measuring the online services sub-index must change and adjust to evolving realities.

This same model can be applied in various fields, including the public, private companies, and markets that are highly sensitive to public opinion. These sectors can leverage the model presented here to identify weaknesses, strengths, and opportunities in the markets where the company operates. This suggests that social media, as elements of high impact on social dynamics, provide opportunities for improvement for businesses. With the correct adjustments to the proposed model, significant value-added business strategies can be generated at a very low cost.

Despite all the advantages of implementing this and similar models, it is surprising, as a result of the research, to find a low number of applications and case studies in the implementation of new technologies for improving political decision-making in Colombia and Latin America. With the approaches developed in this research, it is hoped that new lines of investigation will be opened and existing ones deepened to enhance governmental decision-making supported by technology.

Lastly, the difficulty in accessing the API and data from Twitter and other social networks highlights that the ease of conducting research on large amounts of social data generated by these companies is increasingly limited. This raises concerns and discontent regarding user classification and ethical questions about research and user privacy.

At the same time, there is a growing body of Big Data research based on social networks like Twitter. These studies clarify and specify the limitations of these approaches. Among the limitations are the programming capabilities offered by the API since the data shown to the public is only what is programmed by Twitter, following the company's specific interests. This makes it difficult for researchers to contextualize and fully utilize the data generated by the community. Finally, this type of research is marked by a deficiency in publication models and training for researchers in the field, who are crucial for the growth and development of this area.

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