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Abstract

Social media has dramatically impacted all sectors of society, including public communication and governmental relations. Most countries have increasingly incorporated it into their communication strategies. However, there is little research on this subject. This study tackled this gap by analyzing the existing literature and comprehending the objectives, determinant factors, and consequences of social media use by governments. It investigated the practice of such measures on Portuguese governmental communication to understand the low levels of engagement identified through the research. The governmental accounts were subjected to two types of analysis to achieve a practical means of classification. The exploratory analysis of the @govpt account data (18,071) tweets used various methods specific to user-generated content. Fourteen public agencies' tweets (39,965) underwent the transparency, participation, collaboration, and comfort (TPCC) index computations, developing four factors to calculate the public sector's digital communication success. The TPCC Index results revealed the lowest development rates, with participation and collaboration being the least developed factors. Only 107 mentions were found across 59,036 tweets, and explicit co-creation terms appeared 303 times. Furthermore, the analyzed accounts did not progress to the deeper stages of connection with governments' possible exploration. This research's main achievements and contributions consist of contemplating the Portuguese case study while proposing and validating the TPCC Index metrics' modifications for X data analysis.



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Keywords: public communication; social media analytics; X (Twitter); Portuguese Government; communication success

1. Introduction

The advent of social media, the development of Web 3.0, and the massive amounts of data resulting from these processes have shifted how companies conduct their businesses and should also impact governments [1]. The benefits of incorporating technology in public processes' formulation and implementation [2,3] and how it increases citizen satisfaction and facilitates procedures [4,5] have already been proven. Social networks, microblogging, blogs, review websites, and online forums are a few digital resources governments have to share information and be closer to citizens [6,7].

Effective connections and accountability are some of the requirements from citizens when communicating with the public sector, and governments must provide services in transparent, collaborative, and participative manners to fulfill such requirements [8,9]. Ref. [10] proved how the success of Facebook engagement in the public sector was directly related to citizens' satisfaction in general.

The above facts illustrate the relevance of studies about how governments face, implement, and take advantage of technology through objective analysis and measurement that work in the public interest. The existing research gap indicates neglect regarding social media in governments. The existing literature is mainly related to the debate between media and politics [11,12] or the strategies and projections of X (formerly Twitter) in electoral processes [13,14]. There is an evident lack of focus on studies concerning the public communication scope itself [10].

A persistent digital divide problem in Portugal [15] has led the country to adopt a traditional approach to public administration. In addition, the low adhesion of Portuguese people to modernization efforts, combined with widespread political participation, aggravates the current state of social media [16]. These facts exemplify the estimate that 8.5 million people (83.8% of the total population) were active on social networks in Portugal in January 2022 [17]. Notably, only 2.6% (207,500) of these individuals followed the official government page on X, and 1.6% (130,430) on Facebook. As a light benchmark, contrasts tweet volumes with Spain (@desdelamoncloa) and France (@gouvernementFR); Portugal shows lower activity pre-2016 and a pandemic-era surge consistent with peers.

The study's importance lies in understanding the adoption of new technologies in governance and fostering more meaningful connections with its citizens. This study also helps reduce the significant research gap in the Portuguese public sector's data analysis. Studies that integrate theory and practice to generate innovative insights for the public sector are essential, as they offer solutions to challenges such as low citizen confidence, resource shortages, process simplification, and low public participation [18]. Collecting and exploring real-world data, followed by applying the theories and concepts related to the public sector, can benefit society.

The data collected from a full-archive search of 14 Portuguese governmental X accounts aims to assess the communication quality. The research proposes validating this inspection by distancing from the sentiment analysis approach, which is widely used in X analytics studies [19,20]. This research employed the Data Science Process [21] to structure the study and the TPCC Index [22] to evaluate the data.

Therefore, this research intends to generally analyze both the theoretical and the practical aspects of public social media communication on X through the following specific objectives:

1. Study the importance of social media techniques for public sector communication and the determining factors for a successful strategy.
2. Use of analytical tools to identify patterns and deficiencies in governmental communication of the X Portuguese study case.
3. Calculate the TPCC Index [22] for 14 governmental agencies' tweets to classify the communication regarding their transparency, participation, collaboration, and comfort efforts.

This report is structured into six sections: Introduction, Literature Review, Methodology, Results and Discussion, and Conclusion. The introduction consists of an overview of the topic, its relevance, and the objectives of this research. The literature review presents all theoretical aspects, concepts, and related previous studies to support the ideas regarding public communication, social media, and X analytics. The methodology explains the processes and methods used. It encompasses all data processes, from collection to pre-processing. It utilizes five distinct techniques to enhance the understanding of X data, including time series, public metrics, and topic modeling, as well as TPCC index calculations. Section 5 contains all the results and comparisons to previous studies. The conclusion resumes the paper and provides recommendations for future work.

2. Literature Review

2.1. Social Media

Social media tools are described as “communication systems that allow their social actors to communicate along dyadic ties”, combining elements of communication and social sciences [23]. They relate to the new forms of exchange between actors. Other authors use other Internet concepts, such as Web 2.0 and User Generated Content, to base their definition of social media as “. . . a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, allow the creation and exchange of User Generated Content” [24]. Recent work with European local governments shows that social media is used not only for outreach but also for substantive SDG-related disclosure, underscoring its continuing governance relevance [1].

Other authors base their research on two different forms of defining social media: the attribute approach and the typology approach. The first one is based on properties that characterize social media and is summarized by the authors in three points: “being web-based, providing means for individuals to connect and interact with content and other users, and providing means for users to generate and distribute content on the respective platforms.” [25]. Second, the typology approach observes the different ways in which social media is represented, in other words, the platforms of interaction, which are blogs, social networking sites, collaborative projects, content communities, virtual social worlds, and virtual game worlds [24].

Social media relations are characterized as “dynamic, interconnected, egalitarian, and interactive organisms” [23]. These facts are the main distinguishing characteristics between social media and all other media types. In other words, it is one-dimensional and egalitarian because one node in the network cannot be more potent than another. Other critical facts to remember are the channels of data distribution that compose social media. The channels should be “multi-way, immediate and contingent” since these are internet applications designed and accessed by humans.

Social media analytics is a discipline derived from different subjects, including social network analytics, natural language processing, data mining, information retrieval, mathematics, and sociology [26,27]. Social media analytics is responsible for “representing, analyzing, and extracting actionable patterns from social media data” [27]. It is also described as collecting, monitoring, analyzing, summarizing, and visualizing social media data, aimed at detecting specific requirements by [28].

The relevance of social media data analysis is related to the intelligence aspect of management since these channels simplify access to competitive information [29]. Studies prove that companies that employ social media analytics methods benefit from more effective conversations and interactions with consumers, the ability to extract patterns that serve organizational goals, better brand positioning, performance benchmarking, and crisis management tools [28].

Social media analytics techniques face challenges that may impact data collection, analysis, and interpretation, especially considering that it is a big data source. Some authors correlate these challenges to the “4 Vs of big data”: volume, velocity, variety, and veracity [30]. This challenge involves the massive and constant production of data, alongside an increase in the quantity of data types, resulting in an increasingly unhindered data creation process. Ref. [27] defined four significant challenges faced by the discipline:

- Big Data Paradox: Access to valuable information is complicated by specific subjects and the vast amount of data generated by social media.
- Obtaining sufficient samples: The Adversities data collection process leads to mistrust in the representation of the data and correct pattern identification.

- Noise Removal Fallacy: Removing elements during data preprocessing could eliminate valuable content for other analyses.
- Evaluation Dilemma: Social media data is often not accompanied by test data, hindering the validation of the analytical methods.

Regarding the organization for social media analytics studies, Ref. [31] presented a framework consisting of three steps: tracking, preparation, and analysis, reinforcing the methods used in the analysis. Ref. [32] proposed three steps for the process: capture, understand, and present. In the first phase, data are collected and preprocessed. Subsequently, the corresponding technique is applied, and in the last step, the results are summarized and arranged for visualization. Ref. [33] extended the previously mentioned methodology into a framework that started with the steps “Formulate” and “Determine”, followed by the three steps proposed by the previously mentioned authors. The reasoning behind adding the steps was that intelligent planning and organization are directly related to a successful social media analytics process.

2.2. X Analytics

Twitter is a microblogging social network application launched in 2006, based on short messages called “tweets”, which are limited to 280 characters. Twitter was rebranded X in 2023 (in the study, we only use the term X). It is currently one of the most active and prominent social media platforms [34], having reached 370 million monthly active users in the first quarter of 2019, according to [35]. The high usage rates lead to a large volume of user-generated content, causing authors to classify X as a big data source [36].

Like most social media, X data is naturally unstructured, demanding elaborate techniques and processes to extract valid information and insights [37]. Authors classify the analytical methods used on X by the target, either network analysis or text mining analysis [38]. In other words, user-centric or tweet-centric [39]. The network analysis techniques are developed using indicators such as the number of followers and engagement metrics, while text mining techniques include sentiment analysis and topic detection. Recent evidence from Chinese local government accounts confirms microblogging’s central role in governmental crisis and risk communication, clarifying determinants of platform use and responsiveness [7]. These determinants are directly relevant for the Portuguese context, where responsiveness remains modest, suggesting that lessons from China can help explain low engagement levels observed in our dataset.

The development of X data research began with the Arab Spring in 2011, a period marked by a significant increase in the use of X. The possibility of real-time analysis led researchers to use this type of data to understand patterns accordingly to situations [36]. X analytics was also proven effective in the setting of natural hazard events from a situational awareness perspective [40], such as Hurricane Irene [41] and Japanese earthquakes [42]. Other authors proved the relevance of X analytics in predicting election results [43,44].

According to [36], sentiment analysis is the most common analysis performed on X data and is described as extracting sentimental tendencies from tweets. Each tweet is classified into positive, negative, or neutral through either machine learning, lexicon, or rule-based approaches. The machine learning methods require training an algorithm designed to classify sentiments based on specific rules. The lexicon defines the polarity of each word to identify sentiment rates in a document through pre-existing libraries. Finally, the rule-based approach measures the sentiment through a set of predefined rules [45].

Considering the different techniques used for social media data, Ref. [46] proposed a framework composed of three types of analysis to extract information from tweets. These were descriptive, content, and network analysis. In further developing this framework, Ref. [47] proposed adding geospatial or space-time analysis, which is responsible for

mapping public response in a location-based investigation. The techniques mentioned and the corresponding metrics are presented in Figure 1.

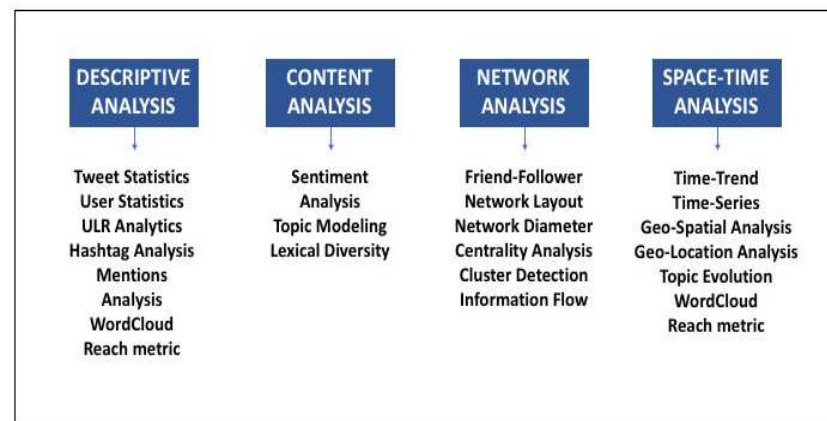


Figure 1. X analytics techniques. Adapted from [46,47].

2.3. Social Media in the Public Sector

It is undeniable that the use of social media brought along more possibilities for democratic participation and changes in behavior in the public sphere [48]. It has also already proven to be an asset in public communication for its ability to increase citizen trust since it directly impacts citizens' notions of transparency and, therefore, benefits the relationship with the government [49]. In parallel, comparative work on accountability across European public agencies highlights how differing accountability styles shape expectations for transparency and public communication online [8]. This expectation highlights that Portugal's comparatively low engagement cannot be fully understood without considering the accountability traditions shaping citizen expectations. According to [50], the main goals of social media use in public communication are interacting with the outside world, developing a transparent government policy, establishing a policy support base, and creating a positive image.

The differences between how social media is perceived in marketing and public communication are related to the expected outcome. While the focus on marketing communication is the development of conversations between the brand and customers, aiming to maximize profit, on the other hand, the public sphere's intention is to inform and engage citizens on public processes while giving an account of governance conduct [51].

Ref. [52] coined the term "Government 2.0", describing it as utilizing Web 2.0 tools and techniques to govern. The concept was developed to contrast with its predecessor, Government 1.0 (or e-government), which focused on information delivery to citizens [53]. Amidst these concepts, the "Open Government" methodology was designed to disrupt the traditional manner of distant and cold governments [54]. Barack Obama's administration popularized the concept of transparent, participative, and collaborative public affairs. Social media is a powerful tool to achieve Open Government goals, increase democratic engagement, and involve citizens who are withdrawn from governmental processes [49].

Developing along the Open Government principles mentioned previously, Ref. [55] proposed a maturity model measured by social media engagement:

- Level 1—Initial Conditions: Rare use of social media and low interest from citizens.
- Level 2—Data Transparency: The first step towards Open Government, as public agencies begin sharing more of their data with citizens, albeit with limited activity.
- Level 3—Open Participation: Regular use of social media and conversation development. The government already has feedback and activity to analyze.

- Level 4—Open Collaboration: Total collaboration and co-creation of policies through social media interactions.
- Level 5—Ubiquitous Engagement: Continuous public engagement and increased transparency, collaboration, and participation.

Considering the expected outcomes, researchers suggest current public social media efforts should be citizen-centric to validate the benefits of two-way interactions instead of the traditional one-way. It means the State should inform citizens about public processes, create conversations, gather opinions and suggestions, and use them for constant service improvement [56]. Therefore, the coproduction of public services and policies is the ultimate goal of social media use in government. However, a worrying number of countries do not employ or employ these resources poorly, and public personnel are not prepared to utilize such resources [57].

External factors also impact the success of public communication, such as the lack of interest of the mass media in an open conversation between the government and citizens, reinforcing the idea of public communication as propaganda [58]. Furthermore, the obsolescence of public policies related to social media use, such as data privacy, security, and accuracy, is hindered by the fact that social media platforms are owned by private companies, which limits regulation [49].

The Portuguese Case

In Portugal, the percentage of individuals who obtain information from public authorities through the Internet has risen from 35% in 2019 to 42% in 2021 [35]. Even though information consumption numbers are high, online interactions with the government do not follow the same trend. This fact can be interpreted through the sociological lens of Portuguese people's online behavior, which tends to be more receptive than proactive. In other words, they access social media to consume content rather than interact with it [59]. Furthermore, historically, Portuguese people present a weak tradition of civic mobilization and political participation [60].

Studies on public communication in Portugal focus mainly on the State's radio and television services, which, although now independent, still represent the most used communication channels between the government and citizens [61–63]. Another research subject was the political application of social media during elections [64]. Moreover, recent studies have been developed regarding the health perspective of Portuguese public communication related to the coronavirus pandemic management [65,66].

Ref. [16] intended to establish the impact of social media platforms on the Portuguese government. The authors draw their conclusions from a citizen-centric analysis and a government-centric one. At the population level, it validated Portugal's recreational aspect of social media use. While at the governmental level, the research indicated that despite the advances, the Portuguese government had yet to fully internalize the benefits of social media in its processes. Indicating cultural and structural changes are necessary for close and transparent relationships with citizens [16].

2.4. Transparency, Participation, Collaboration, and Comfort

Ref. [22] introduced the TPCC Index within the framework of communication success. This framework proposes metrics to measure government communication efforts on social media through Open Government principles. The authors point out that the benefits the public sector can achieve through social media are transparency, participation, and collaboration, adding the comfort factor, which is considered vital for the success of governmental social media. Aligned with these dimensions, recent smart-city research links digital dialogue and government responsiveness to higher citizen satisfaction, reinforcing

the importance of participation and collaboration metrics [5]. This finding resonates with the Portuguese case, where low participation and collaboration indices indicate a pressing need for improved dialogue mechanisms if similar gains in satisfaction are to be achieved.

The framework was applied by [22] to analyze and compare the presence of Arabic countries on social media. The authors concluded that the content's negative aspects were the low government activity, the one-way communication, and the lack of discussion. In contrast, different multimedia and multi-channel presence positively led to higher engagement. Ref. [67] proposed and developed the concept using part of the framework to analyze the relationship between transparency, participation, and collaboration with the government's continued use of social media in the Malaysian case study.

A study by [10] was based on the development of the TPCC Index. The first step of the research was an assessment of the properties from 15,941 Facebook posts from the 25 largest German cities. Five factors were proposed: Provision of current information, Marketing, Co-Design, Facebook Transactions, and Multimedia features. Although the metrics are divided across different factors, they are similar to the TPCC Index. Further research steps were dedicated to a sentiment analysis of the interactions with said posts [5].

The metrics from the TPCC index are specific to each factor. The transparency, participation, and collaboration indices are calculated by counting all posts that fit the metrics and dividing each subject's metric result by the maximum value for that metric. These values are summed per subject and result in the index values. On the other hand, the comfort index is calculated by summing all posts that fit the comfort metrics by account and subsequently dividing it by the total number of posts that include the metrics in the sample.

$$\text{Transparency, Participation, Collaboration Index} = \frac{\text{metric1}}{\max(\text{metric1})} + \frac{\text{metric2}}{\max(\text{metric2})} + \frac{\text{metric3}}{\max(\text{metric3})} \dots \quad (1)$$

The comfort index, on the other hand, is calculated by summing all posts that fit the comfort metrics by account and subsequently dividing it by the total number of posts that include the metrics in the sample.

$$\text{Comfort Index} = \frac{\text{metric1}}{\text{total metric1 in sample}} + \frac{\text{metric2}}{\text{total metric2 in sample}} + \frac{\text{metric3}}{\text{total metric3 in sample}} \quad (2)$$

After the measurement of each factor's index, the TPCC index is calculated as follows:

$$\begin{aligned} \text{Comfort Index} &= \frac{(\text{metric1} + \text{metric2} + \text{metric3})}{\text{total}} \text{metrics in samp} \\ &= \text{Transparency Index} + \text{Participation Index} + \text{Collaboration Index} + \text{Comfort Index} \end{aligned} \quad (3)$$

3. Materials and Methods

The Data Science Process's steps are similar across different research areas. Its singularity comes from the notion of data undergoing an exploratory analysis and the application of other statistical models [21]. First, there is the collection of raw data from real-world situations, followed by the processing and filtering steps that complete the data preparation for the proposed analyses.

We adopt TPCC because it operationalizes Open Government principles (transparency, participation, collaboration, comfort) in a way that is platform-agnostic yet auditable; adapting it to X extends prior uses centered mainly on Facebook. Five different types of evaluations composed the exploratory analysis for the present research. While the transparency, participation, collaboration, and comfort index [22] calculation was the statistical method applied. All results were then summarized, analyzed, and presented

using data visualization techniques following this study's methodology, illustrated in Figure 2. The study did not employ the proprietary X analytics dashboard. We conduct social media analytics on Python 3.10.

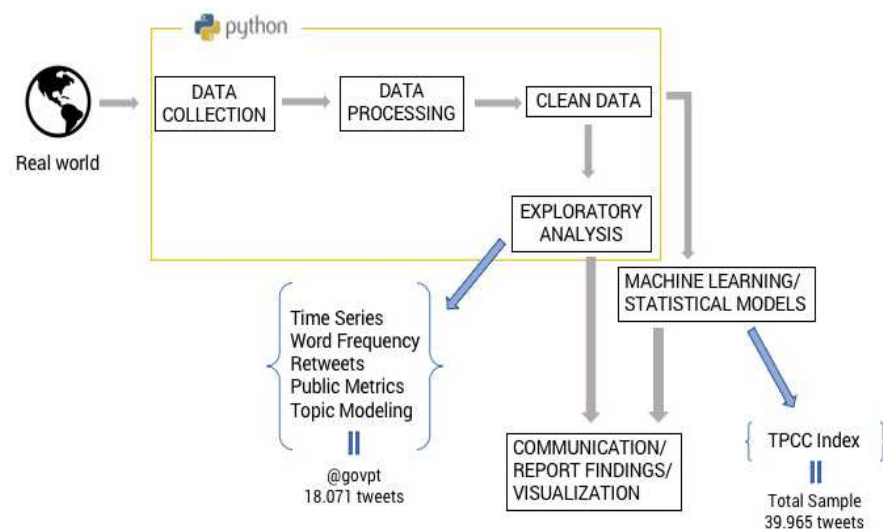


Figure 2. Representation of this research's methodology based on [21,22].

The data were collected from the official Portuguese government X account (@govpt) and thirteen other governmental agencies' accounts, described in Appendix A. The collection was performed through the X Academic Research API. Python was used to process and manipulate the data from the collection step until the exploratory analysis calculations. The exploratory analysis was performed on the first sample, which consisted of 18,071 tweets from the @govpt account. At the same time, the TPCC Index calculation required a complete sample that contained all tweets from governmental agencies. Each step is presented in Figure 2, and the data attributes are described in depth in the following subsections.

3.1. Data Collection

We focus on X, given its full-archive Academic Research API, its use for real-time governmental announcements in Portugal, and the novelty of adapting TPCC beyond Facebook. Data were collected in December 2021, encompassing a period from 28 May 2009 (1:13 pm) to December 2021. Our period ends in December 2021 to provide a stable, pre-ownership-change baseline (Twitter→X rebrand, and platform policy shifts commenced later). The results, therefore, characterize the pre-2022 regime; we explicitly caution against extrapolating beyond 2021.

The extensive time frame was due to the low activity levels on the accounts, with an average of 3.92 posts per day, spanning distinct mandates and the pandemic. A small sample required a complete analysis to extract valuable information from the data, for instance, the changes between different government mandates and the differences between accounts. The total sample description (59,036 tweets) is shown in Table 1.

As shown in Table 1, the @govpt (República Portuguesa) and @defesa_pt (Ministério da Defesa) were created seven years before the other accounts; therefore, they present more data. Due to this disparity, the present research's objective was not to compare the accounts but to measure the quality of X communication.

From the total amount of tweets, it was also observed that 30,010 used images, and 14,646 were retweets from other accounts. The variables collected from each tweet are exposed in Table 2, including a description and summary of statistics that characterize the data sample. All variables collected were used in the techniques employed in this

research. The public metrics, which are retweets, replies, likes, and quote counts, represent the engagement a tweet stimulates and are essential in measuring communication success.

Table 1. Sample description.

Tag	Creation Date	Total Tweets in Sample
@govpt	04/2009	18,071
@agricultura_pt	03/2016	2989
@ainterna_pt	03/2016	2900
@ambiente_pt	03/2016	2768
@ciencia_pt	03/2016	2721
@cultura_pt	03/2016	3036
@defesa_pt	03/2009	6664
@educacao_pt	03/2016	2107
@iestructuras_pt	03/2016	2166
@justica_pt	03/2016	1915
@nestrangeiros_pt	03/2016	3818
@planeamento_pt	03/2016	2442
@saude_pt	03/2016	2016
@trabalho_pt	03/2016	4423

Table 2. Data description and summary.

Variable	Description	Data Type	Min.	Max.	Mean
id	Identification marker for each tweet	String	-	-	-
created_at	Date of tweet creation	DateTime	-	-	-
text	The actual content of the tweet	String	-	-	-
retweet	Number of times the tweet was retweeted	Integer	0	4332	6.525
reply	Number of times the tweet was replied to	Integer	0	190	0.661
like	Number of times the tweet was liked	Integer	0	1714	7.383
quote	Number of times the tweet was quoted	Integer	0	105	0.553

3.2. Preprocessing

The collection phase resulted in a .csv file, which was then organized on a Dataframe using the Pandas library [68] to process and adequately analyze the data. This stage is crucial when handling user-generated content and unstructured data. Several preprocessing techniques were used, including X-specific methods like removing tweet tags, as well as more general approaches for preprocessing all linguistic data.

The main steps of the preprocessing were as follows:

- Removal of links: such as “HTTP”, “bit.ly”, “pic.X”, and other links in general, to keep only text.
- Removal of X specifics: RT tag and user identification (@).
- Removal of special characters and punctuation.
- Lower case normalization.
- Removal of stop words: using NLTK, the Natural Language Tool Kit Portuguese dictionary. Removal of connectors and words that represent no value and could cause disturbance in the analysis.

- Lemmatization: a process of normalization that reverts inflected words to their dictionary form.
- Tokenization: Tokenizing words in a text separates each word into an individual object.

After the preprocessing techniques were performed, two fields were added to the original Dataframe: “clean_tokens”, consisting of the remaining words split into individual elements, and “clean_tweet”, where the clean text was kept in its string form. Since different analyses require different forms of preprocessing, the data were split into two different datasets to perform the exploratory analysis on the @govpt’s data only (18,071 tweets). A complete dataset, composed of all the accounts, was used for the TPCC Index measurements.

3.3. Descriptive and Exploratory Analysis

We conducted a descriptive and exploratory analysis (EDA) on @govpt to characterize longitudinal patterns and guide the subsequent TPCC evaluation. The TPCC computations then use the full 14-account dataset [69]. It aggregates methods for primary analysis that can detect mistakes, check assumptions, determine the relationship between variables, and enable the correct selection of models and techniques for later use. We focused the EDA on @govpt to avoid over-weighting accounts with disparate lifespans/volumes and to keep the descriptive overview concise; all inferential classification (TPCC) uses the complete dataset. For this objective, the techniques employed were time series, public metrics, and topic modeling. Sentiment classification was intentionally excluded due to known challenges in Portuguese governmental communication, such as domain-specific vocabulary, irony and sarcasm, and politicized lexicons. This decision ensured methodological rigor and interpretability. Instead, we prioritized auditable, structure-based indicators (TPCC).

Time Series: In time series analysis, data are analyzed through observation dates and over an interval, allowing for a sequential report demonstrating how variables behave over time. According to [70], time series is helpful for forecasting values, separating valuable information from noise, eliminating the seasonal component, and identifying external events that influence variables. It converged with the primary objective of this study, which was to understand how patterns shifted according to time.

The selected approach to visualize this time series analysis was the regression line, considering the intent was to establish the trend, that is, the relationship between two variables: time (in years) and the number of posts. The year of each publication could be isolated through the “created_at” field of the tweet’s object in DateTime. Subsequently, all tweets were grouped by year of creation and counted. The results were then prepared for visualization on a regression line using Matplotlib [71].

Public Metrics: Metrics from X, also called engagement metrics, represent the interaction between users and tweets. Retweets, likes, replies, and quotes are essential metrics to identify public preferences and measure account interaction. They are public metrics, meaning users can see these values when browsing a public X account. The most interacted tweet for each category of interaction was identified and presented.

Topic Modeling: For the word frequency analysis, the visualization technique selected was the word cloud, where words are organized in a figure of different sizes representing the frequency with which each term is mentioned throughout the document. All terms in the sample were combined on a string and served as input for the built-in function from the Matplotlib package [71] that generated the graph.

Since every text document is composed of words, topic modeling is a technique that identifies the highly related words to determine the topics of a document’s discourse [72]. Therefore, each document has several topics, each composed of several words.

The method used in the present study was the Latent Dirichlet Allocation, also known as LDA. Besides choosing it because it is the most used method for topic detection in text mining, which employs probability to identify the share of each topic in the documents, we also selected it for its interpretability, stability over long time spans, and ease of integrating Portuguese stopwords and lemmatization. Transformer-based BERTopic and NMF were considered, but they would add complexity and model-selection overhead in a multilingual/bureaucratic lexicon without necessarily improving interpretability for policy audiences. In this method, several topics must be provided as input. In other words, it does not automatically infer K . To calculate the optimal number of topics for the documents that compose this research's sample, the Coherence Score and "Elbow method" resulted in seven topics (Figure 3).

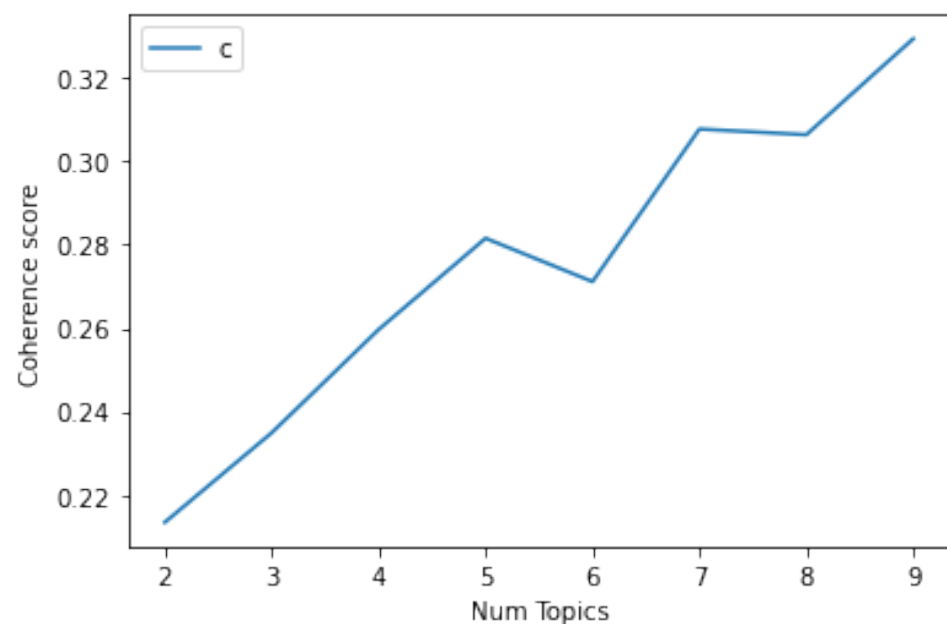


Figure 3. Coherence score.

3.4. TPCC Index

The original metrics and their corresponding factors proposed by [22] were designed for Facebook data analysis. One of the contributions of the present research is the proposal of metrics adapted for X's evaluation of the TPCC Index. In this process, the authors mentioned that some metrics changed and others had to be eliminated, specifically the metric that referred to calendar events, since X does not provide such a feature. The metrics used in this study are displayed in Table 3.

Table 3. Table of measures and metrics for the TPCC index on X data (adapted from [4]).

Factor	Metrics	Measures
Transparency	Number of published posts	Number of published posts ÷ total number of posts
	Number of posts that include photos	Number of posts that include photos ÷ total number of posts in the sample
	Number of posts that include videos	Number of posts that include videos ÷ total number of posts in sample
	Number of posts that include broadcasts	Number of posts that include broadcasts ÷ total number of posts in sample
	Number of posts that include other social media	Number of posts that include social media ÷ total number of posts in sample

Table 3. Cont.

Factor	Metrics	Measures
Collaboration	Number of posts that request citizens engagement	Number of posts that request citizens to engage ÷ total number of posts in the sample
	Number of posts that request citizens to co-create	Number of posts that request citizens to co-create ÷ total number of posts in the sample
Participation	The government website enables stakeholders to post on their page	If the government allows for its If stakeholders post, a value of 1 will be allocated; otherwise, a value of 0 will be allocated.
	Number of posts with a survey	
Comfort	Number of posts that include a link to e-government websites	Number of posts with a link to the e-government website ÷ total number of posts in sample
	Number of posts that include a link to an external website	Number of posts with a link to an external website ÷ total number of posts in sample
	Presence of a link to the governmental website on the page	If the link exists, a value of 1 will be allocated; otherwise, zero will be allocated.

The metrics calculated according to the measures presented in the table above were then used to calculate the index for each of the four factors described in Section 2.4. Therefore, the factor's index is the sum of all its corresponding metrics divided by the number of metrics.

3.4.1. Transparency

Following the Open Government principles presented previously, several authors related transparency to successful communication in the public sector [73,74]. In their framework development, Ref. [22] emphasizes the importance of transparent government communication and information as public assets. Therefore, the transparency metrics relate to posts that are easily accessible and interpretable, such as multimedia and other social media posts.

To calculate the number of multimedia and broadcast posts, the entities on the Tweet object were accessed to uncover if the tags for images and videos existed and how frequently they existed. For the social media posts, it was necessary to count the word frequency of the names of the three leading social media platforms: "Facebook", "Instagram", and "YouTube".

3.4.2. Collaboration

The Collaboration factor evaluates the government's efforts to enable citizen engagement and co-creation. According to [75], incorporating citizen knowledge and understanding is the main benefit a government can achieve by implementing collaboration into its processes. It can enhance public engagement and participation while taking advantage of new ideas and opinions.

Therefore, a word frequency analysis was performed to identify the posts that fit the metrics for collaboration. Through raw data observation, it was possible to list the most used terms for engagement and co-creation requests and count their frequencies. The terms were defined as follows:

- Engagement: "visite", "saiba", "leia", "consulte", "acompanhe" e "assista".
- Co-Creation: "vote", "escolha", "colabore", "submeta", "ajude" and "participe".

The collaboration lexicon was derived deductively from the Open-Government/participatory-governance literature and inductively from Portuguese imperative forms observed in the corpus. We operationalized collaboration using the following base lemmas (matched case-/diacritic-insensitively and counting common inflections/imperatives):

participar/participe, responder/responda, votar/vote, inscrever/inscreva-se, enviar/envie, colaborar/colabore, co-criar/co-crie, partilhar/partilhe, comentar/comente, sugerir/sugira, propor/proponha, perguntar/pergunte, convidar/convide, contribuir/contribua. We acknowledge that keyword rules can miss context (e.g., polysemy, irony/sarcasm, negation). We therefore treat them as auditable signals rather than definitive intent. Tokens are normalized by lemma with diacritics stripped; obvious boilerplate/UI strings are excluded; counts are computed at the post level.

3.4.3. Participation

Participation enables citizens to engage in public topics and decisions. For that reason, the metrics of this factor are related to whether the e-government page allows users to post on it and the number of posts made by governmental agencies containing surveys to enquire about public opinion [10].

The Portuguese government account allowed citizens to post and interact over their account, as with any other public X account. Users could reply, mention, and retweet the public agencies' posts. Due to this, all accounts received a score of 1 on this Boolean value metric. The second metric was calculated by accessing the entities of each tweet object and checking the frequency of "poll" entities for each page.

3.4.4. Comfort

In comfort, the framework refers to the use of social media and the Internet for the sharing of information and resources by the government, providing an accessible and multi-faceted presence online. It allows citizens to connect more with the agencies, reinforcing the sense of trust. In this case, the metrics refer to how links are distributed throughout the governmental agencies' X accounts. The first step was to assess whether links to governmental websites were included in the account descriptions. The results were 1 or 0, indicating the presence or absence of such redirection.

Secondly, posts containing links were analyzed to separate them into URLs redirected to government websites and those redirected to external ones. Due to the automatic URL shortener employed by X to save characters on a post, it was necessary to access the entities field to collect the "expanded_url" information. Considering that all governmental websites follow the ".gov.pt" domain. Lastly, the count of external and internal links was calculated through a separate term frequency analysis on the list of URLs.

4. Results and Discussion

This section summarizes the results from the exploratory analysis and the TPCC index evaluation, along with their interpretation.

4.1. Exploratory Analysis

The results from the primary data analysis of the @govpt account are summarized in this subsection.

4.1.1. Time Series

Figure 4 illustrates the increasing trend in publication frequency. It also shows low activity in the first six years (2009–2015), followed by an increase in the following six years (2016–2021). During 2013, there were no tweets in the count. However, the year with more tweets was 2021 (3321), which aligns with the digital communication activity during the COVID-19 pandemic.

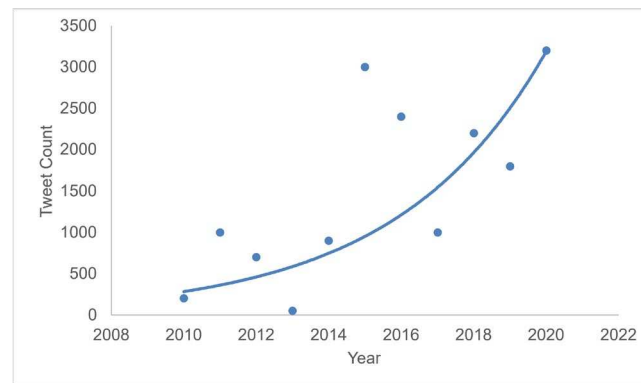


Figure 4. Tweets per year (@govpt).

The account was created in 2009, during the second mandate of Prime Minister José Sócrates. In the following year of his mandate, 2010 (1069), the activity almost tripled, while in 2011 (681), it decreased significantly. Increased efforts from the government in digitalization marked this mandate. The analysis concluded that this mandate was the one that most frequently used the term “internet” among the four mandates [76].

When Pedro Passos Coelho was Prime Minister, the activity in the account was inadequately low, especially in the first two years, 2012 (5) and 2013 (0). However, 2014 (436) and 2015 (872) presented higher posts. From 2016 onwards, with António Costa as Prime Minister, the use of X increased compared to the previous periods, also influenced by a rise in social media usage. In addition to external events, such as the coronavirus pandemic, which can be considered responsible for the peaks during 2020 (2340) and 2021 (3523), governments intensely used the platform during these periods [65].

The posting activity from the @govpt was compared to Spain’s @desdelamoncloa and France’s @gouvernementfr from 2013 to 2016 for benchmarking. Figure 5 shows that the Portuguese account had the lowest activity throughout the analyzed period. All governmental accounts experienced a rise in activity in 2015, followed by a deceleration between 2018 and 2019, and then another increase in 2020 and 2021, which was related to the coronavirus pandemic [65]. The final period depicted that the French government’s communication was the most positively impacted by the pandemic.

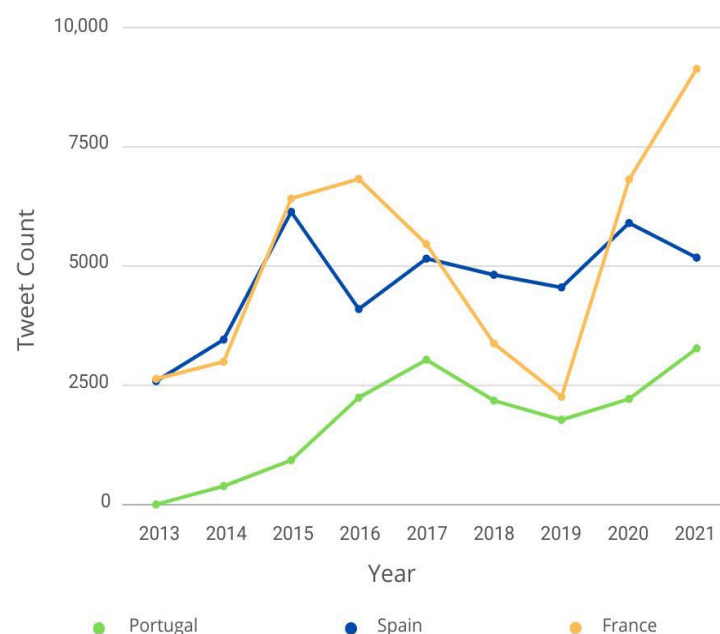


Figure 5. Portugal, Spain, and France tweet count per year.

4.1.2. Public Metrics

- Retweets and Likes:

The most retweeted tweet was also the most liked (Table 4). It was a link to the Minister of Foreign Affairs' pronouncement recognizing Juan Guaidó as the president of Venezuela in 2019, which received few replies or quotes. The average of retweets in the sample was 6.52, and the average of likes was 7.38. These values represented a low level of interaction with the account.

Table 4. Most retweeted and most liked tweet.

Text	Created at	Retweets	Replies	Likes	Quotes
"Portugal recognizes Juan Guaidó as Presidente interim President of Venezuela in speech from the Minister of @nestrangeiro_pt https://t.co/veVNCUztjK " (accessed on 7 November 2022)	2019-02-04 16:36:20	992	163	1714	100

- Replies:

The average of replies in the sample was 0.66, a minimal mean, symbolizing the low engagement in conversations on the account since replies are the most connective of the public metrics. The most replied-to tweet (Table 5) was the link to the video of Prime Minister António Costa's speech about the European Council in the first days of the coronavirus pandemic, which depicted motivation from citizens to communicate with the government in moments of uncertainty.

Table 5. Most replied-to tweet.

Text	Created at	Retweets	Likes	Replies	Quotes
Announcement of the Prime Minister—European Council Meeting, 26 March 2020, https://t.co/PgsWIYRB99 (accessed on 7 November 2022)	2020-03-26 21:39:19	263	190	1041	102

- Quotes:

The average of quotes and re-shares of a tweet with a comment was 0.55, again representing a low engagement rate. The most quoted tweet (Table 6) discoursed about the National Health Service and had an overall low number on all public metrics, with only 105 quotes.

Table 6. Most quoted tweet.

Text	Created at	Retweets	Likes	Replies	Quotes
In the last 5 years, the @SNS_Portugal was reinforced with more than 22.000 Health Professionals #FactosSNS #OE2021 https://t.co/4H5iNICEkz (accessed on 7 November 2022)	2020-10-27 10:25:29	24	50	110	105

An important fact to notice is that all tweets presented above were recent. The most liked and retweeted post was from 2019, while the most quoted and replied-to tweets were from 2020. This number illustrated the growing interest of users to engage with the account once publication frequency was consistent. It also implied that Portuguese people prefer posts that do not involve heavy subjects. At the same time, the reply and quote features were mainly used on content that instigated opinions, which aligns with findings from previous studies regarding different countries' social media communication [10,75].

Comparing these results with the most interacted-with posts from Spain's and France's governmental accounts, two detections were possible. First, the significantly lower number of interactions from the @govpt account. Secondly, the content from the most engaged posts was primarily related to the coronavirus pandemic from an emotional perspective. While in Portugal, the only mention of such a period in the tables above was a video of the first press conference from the pandemic, which was also the most-replied-to tweet.

4.1.3. Topic Modeling

This subsection presents the results in word clouds, first on a general inspection and second according to the main topics identified. Later, the topics were analyzed according to the political period Portugal was experiencing.

Through the analysis of the word cloud presenting the most used terms from the sample, displayed in Figure 6, it was possible to identify a tendency to employ political and economic terms, such as “ministro”, “conselho”, “nacional”, “governo”, and “estado”. Moreover, the presence of the word “covid” carries a heavier meaning, as it was only mentioned for two of the twelve years in the time range. These findings align with [65], who concluded that “covid” was the main topic during the first two years of the pandemic.



Figure 6. Word Cloud of the most used terms.

According to [10], the terms used in communication point the behavior toward a traditional way of interacting. The focus is more on providing information than on stimulating participation and feedback from citizens.

The seven identified topics were titled according to the subject they mainly described. The main terms from each topic were arranged in Word Cloud form and presented in Figure 7; each topic is further described.



Figure 7. Word Cloud of the most used terms for each identified topic.

- **Events:** Composed mainly of expressions that refer to events, since the main terms were: “preside”, “ceremony”, “opening”, and “Lisboa.” The name “Pedro” indicates a relation to Pedro Passos Coelho’s mandate.
- **Press:** This topic was mainly related to the press conferences of the government. It mentions António Costa and the coronavirus pandemic, probably due to the regular press conferences during the pandemic.
- **Election:** This topic primarily focused on the election period and the definition of the State budget, as it involved terms such as “budget”, “economy”, and “debate.”
- **Minister’s Council:** The most occurring terms were related to the “council of ministers”, its reports, and broadcasts (“directo”, “comunicado”, “portal”).
- **European Union:** This topic contained words related to the European Union meetings, measures, and mentions of higher education.
- **Internal Administration:** This topic presented general terms but explicitly mentioned the Internal Administration Ministry (MAI). Regarding the mentions of Rui and José, it could be referring to José Sócrates’ mandate and Rui Pereira, Minister of Internal Administration, in the same period.
- **Economy:** The terms on this topic were primarily related to investment and public services. It mentions the economy, social security, and health.

The results illustrate a more substantial presence of terms related to the State and politicians than to public services or deeper sources of interest for citizens. In [22], the seven most frequent topics were: “Technology Information”, “Islamic Communication”, “IT Workshop”, “Education”, “Competitions”, “Civil Status News”, and “Work”. From those, the most engaging topics were “Competitions” and “Technology Information”, which are themes involving citizens in some way. It corroborated with [10], who identified higher interaction with posts about “Competitions and awards”, “Schools”, and “Zoo/Botanical Garden.”

The topics were then classified into a yearly time series to analyze the topic’s evolution over the years and different political mandates. The results are displayed in Figure 8 and analyzed in the following paragraphs according to each Prime Minister since the creation date of the X accounts in 2009 during José Sócrates’ mandate (2009–2011), Pedro Passos Coelho (2011–2015), and António Costa (2016–2021).

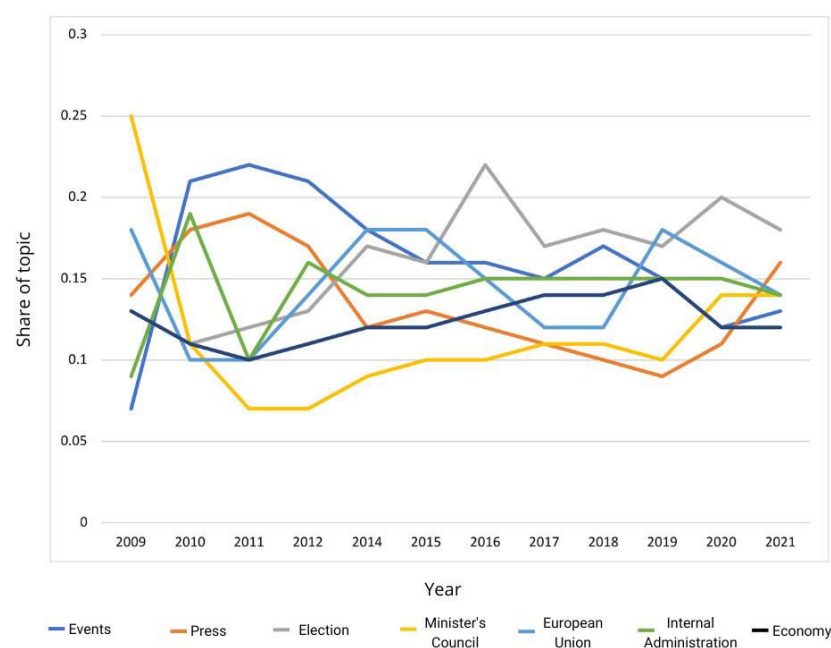


Figure 8. Topics evolution over time (2009–2021).

The first period analyzed was 2009–2011, during José Sócrates’s mandate. Although activity during this period was sporadic, the analysis of available data reveals spikes in topics such as “José Sócrates”, “Economy”, and “Press”. Pedro Passos Coelho’s presidency was marked by economic measures designed to deal with the Troika effects and to fight austerity [77], which could explain the emphasis on terms related to the economy and the prevalence of the topic “European Union” and “Economy.” While the topics “José Sócrates” and “Events”, which were the most mentioned topics in the previous period, suffered a decrease in share.

António Costa’s first government (2015–2020) was the first mandate with consistent tweet activity throughout the years. As the graph indicates, the communication was diverse in terms of the topics shared. The increase in topics “Public Services” and “European Union” in the first year reflected well the priorities of the socialist government. Even though the “Economy” topic decreased by 0.04 in share between 2016 and 2017, it was still the most relevant topic throughout the mandate. From 2019 onwards, mentions of the “European Union” topic decreased, while the “Minister’s Council” and “Press” increased; the latter, especially after 2020, when the coronavirus pandemic and press conferences about it became the focal theme of the X communication.

4.2. Transparency Index

Transparency Index’s metrics were the total number of posts in the sample, the number of posts that include multimedia, and the mentions of other social media platform accounts. The results by account are presented in Table 7. The results indicate a significant difference between the total values of posts for the @govpt account, which ranked higher for all metrics except for the number of posts that refer to other social media platforms. For such metric, the accounts @defesa_pt, @ciencia_pt, and @saude_pt presented the highest values.

Table 7. Metrics for the transparency factor for each account.

Account	Total Posts	Images	Videos	Social Media
govpt	18,071	6408	579	14
agricultura_pt	2989	1303	170	0
ainterna_pt	2900	1985	115	4
ambiente_pt	2768	1229	110	8
ciencia_pt	2721	1923	119	17
cultura_pt	3036	1766	72	10
defesa_pt	6664	3698	222	64
educacao_pt	2107	1246	125	4
iestruturas_pt	2166	1012	141	2
justica_pt	1915	1377	72	3
nestrangeiros_pt	3818	1371	103	1
planeamento_pt	2442	1487	29	4
saude_pt	3016	2603	53	15
trabalho_pt	4423	2602	99	0
TOTAL	59,036	30,010	146	146

The percentage of posts that fit in the transparency factor is 38.7% on the @govpt account, the second lowest, only behind the @nestrangeiro_pt, on which it represents 38.6% of the total posts.

Concerning multimedia resources, the data implied a more frequent use of images than videos. Even though both are proven to stimulate more citizen engagement than plain text, videos are considered more efficient [75]. The prevalence of images over videos also aligns with previous studies. For [10], in a universe of 15,941 tweets from local German governments, 215 were images, 66 were videos, and 89 were social media integration [5]. In comparison, Ref. [22] study resulted in 530 images, 63 videos, and 57 social media posts. Therefore, this can be interpreted as wasted opportunities for conveying messages more effectively and increasing user engagement across different platforms.

As exposed previously, to calculate the Transparency Index according to the TPCC Framework, each account's result was divided by the total value for each metric. For example, on the @govpt account, the total posts (18071) were separated by the total posts for all accounts (59036). Secondly, these four results were summed for each account and divided by the number of metrics on the transparency factor, which was four. The results from the described calculation can be verified in Table 8.

Table 8. Transparency Index results for each account.

Rank	Account	Transparency Index
1	govpt	0.902
2	defesa_pt	0.783
3	ustiça_pt	0.285
4	usti_pt	0.265
5	cultura_pt	0.212
6	trabalho_pt	0.209
7	ainterna_pt	0.199
8	ambiente_pt	0.190
9	agricultura_pt	0.177
10	nestrangeiros_pt	0.166
11	ustiça_pt	0.165
12	iestruturas_pt	0.152
13	ustiça_pt	0.132
14	planeamento_pt	0.131

The frequency of publications was directly related to the Transparency Index values, mainly due to the metric “Total number of published posts”, where the accounts @defesapt and @govpt presented the highest results. Compared to the Arabic countries’ official Facebook pages analyzed by [22] and presented in Appendix C, these two Portuguese accounts outperformed all Arab countries analyzed, since the highest value belonged to Tunisia with a Transparency Index of 0.620.

4.3. Collaboration Index

The Collaboration Index utilized word count values from two term categories: one aimed at stimulating citizen engagement and the other requesting co-creation. A word frequency count was performed on Python to identify the frequency of terms belonging to each category that were presented previously, and the results are displayed in Table 9.

Table 9. Metrics for the collaboration factor for each account.

Account	Engagement Terms	Co-Creation Terms
govpt	525	90
agricultura_pt	26	2
ainterna_pt	84	22
ambiente_pt	80	5
ciencia_pt	123	32
cultura_pt	67	6
defesa_pt	286	13
educacao_pt	13	4
iestruturas_pt	315	8
justica_pt	37	16
nestrangeiros_pt	23	12
planeamento_pt	17	5
saude_pt	146	85
trabalho_pt	135	3
TOTAL	1877	303

Through the percentage calculation of collaborative posts for each account, it was pointed out that engagement terms were used six times more than co-creation terms. In percentage terms, the account @iestruturas_pt ranked higher in collaboration (14.9% of total posts), followed by @ciencia_pt (5.6%). The accounts with more activity @govpt only employed collaborative terms in 3.4% of their posts.

The most used term to request engagement was “know”, written in 781 tweets. It was primarily used with links, encouraging readers to click on the URL and learn more about the topic described in the tweet. The most used term to request co-creation from citizens was “escolha” (98 times). This term invites readers to participate in public consultations and the government’s decision-making processes.

The values of engagement and co-creation terms were first divided by the total number of posts in the collaboration category, and then by two, the number of metrics. The results are displayed in Table 10.

Table 10. Collaboration Index results.

Rank	Account	Collaboration Index
1	govpt	0.288
2	saude_pt	0.178
3	defesa_pt	0.097
4	iestruturas_pt	0.096
5	ciencia_pt	0.085
6	ainterna_pt	0.058
7	trabalho_pt	0.042
8	justica_pt	0.032
9	ambiente_pt	0.029
10	cultura_pt	0.027
11	nestrangeiro_pt	0.025
12	planeamento_pt	0.012
13	agricultura_pt	0.009
14	educacao_pt	0.009

All values calculated for the Collaboration Index were lower than the transparency values, indicating that the accounts do not request citizen engagement and co-creation through X. Ref. [10] also identified this problem, as only 14 tweets requested citizens to be involved with the government in the study. Compared to [22], the Portuguese government accounts presented significantly lower Collaboration Index results.

4.4. Participation Index

The values of the Participation Index metrics are presented in Table 11. The first metric refers to how the government enables citizens to post on the analyzed page. According to [4], this metric would only be False (or 0) if the page had limitations on access, such as disabled comments or a private page, which did not happen for any accounts analyzed in the present study [2]. Therefore, the value of 1 was added to all accounts concerning this metric.

Table 11. Metrics for the participation factor for each account.

Account	Posts over the Page	Polls
govpt	1	24
agricultura_pt	1	14
ainterna_pt	1	2
ambiente_pt	1	6
ciencia_pt	1	11
cultura_pt	1	7
defesa_pt	1	3
educacao_pt	1	3
iestruturas_pt	1	4
justica_pt	1	2
nestrangeiros_pt	1	1
planeamento_pt	1	4
saude_pt	1	12
trabalho_pt	1	14
TOTAL	14	107

Through the results for the second metric, posts containing surveys, it was possible to determine low employment of this resource by asking for citizens' opinions, consistent with previous studies [10,75,78]. Ref. [4] Additionally, the limited use of polls was noted, with only 3 out of 12 countries utilizing the resource five times [4].

Studies have proven that digital communication success is directly related to participation among actors [2]. In the research developed by [22], regarding Arab countries, some subjects presented higher results, with a maximum of 0.620 from Tunisia. Still, half of the sample obtained a null minimum. The final values for the Participation Index are displayed in Table 12. The subjects that ranked higher besides @govpt were @trabalho_pt and @agricultura_pt.

Table 12. Participation Index results.

Rank	Accounts	Participation Index
1	govpt	0.206
2	defesa_pt	0.123
3	ainterna_pt	0.066
4	cultura_pt	0.107
5	justica_pt	0.099
6	educacao_pt	0.123
7	nestrangeiros_pt	0.057
8	ciencia_pt	0.041
9	trabalho_pt	0.041
10	agricultura_pt	0.033
11	planeamento_pt	0.033
12	saude_pt	0.024
13	iestruturas_pt	0.024
14	ambiente_pt	0.016

4.5. Comfort Index

Regarding the last factor that comprises the TPCC index, the Comfort Index calculation was based on the presence of links redirected to governmental websites, the number of links to e-government websites, and external ones. Regarding the metric “Presence of link to e-government website”, 1 (True) was summed to all accounts except @ainterna_pt. The link on the account’s description was “portugal.gov.pt”. The results for the remaining metrics are shown in Table 13.

Table 13. Metrics for the comfort factor for each account.

Account	Government Links	External Links
govpt	13,876	1682
agricultura_pt	2649	179
ainterna_pt	2385	337
ambiente_pt	2410	313
ciencia_pt	2320	301
cultura_pt	2675	148
defesa_pt	5964	234
educacao_pt	1981	95
iestruturas_pt	1658	329
justica_pt	2444	87
nestrangeiros_pt	1524	236
planeamento_pt	1980	261
saude_pt	2489	460
trabalho_pt	3679	310
TOTAL	48,034	4972

The data revealed a pattern of link usage in messages, with a notable preference for URLs redirecting users to official governmental pages. These represent 90.6% of all posts that included links in the sample. The posts that were redirected to internal pages followed the same model, a type of news post with headlines and URLs that urged users to access the website for more information.

The results align with [22], where 235 tweets contained internal links, and 103 contained external links. According to [10], external links (2265) were more prevalent than governmental ones (1614) on Italian accounts [5].

It was also observed that the pages with the most external links were @govpt and @saude_pt. However, the @govpt account surpassed all others regarding governmental (13,876) and external links (1682). These data highlighted the need to enhance connections between governmental agencies' websites and social media accounts, as well as with pages from various sectors, ensuring transparency in cooperation and partnerships. The accounts analyzed by [10] also presented low values of URL usage in general [5].

The Comfort Index calculation is performed differently from other metrics, and the results (Table 14) show a similar value between accounts, except for @ainterna_pt, which presented a considerably lower value because it did not sum a value of 1 for the presence of a governmental link on the account description. Ref. [22] results presented an average of 0.080; in the present analysis, the average was 0.380.

Table 14. Comfort index results.

Rank	Accounts	Comfort Index
1	govpt	0.542
2	defesa_pt	0.363
3	saude_pt	0.372
4	nestrangeiros_pt	0.371
5	justica_pt	0.369
6	educacao_pt	0.361
7	agricultura_pt	0.388
8	planeamento_pt	0.353
9	ciencia_pt	0.367
10	iestruturas_pt	0.356
11	ambiente_pt	0.359
12	trabalho_pt	0.364
13	cultura_pt	0.381
14	ainterna_pt	0.038

4.6. TPCC Index

For the final estimation, all four indexes previously measured were summed and resulted in a TPCC Index for each account, shown in Table 15. All results considered, the @govpt and @defesa_pt were the first accounts to be created and therefore had more weight in the sample, yet these were also the most consistent accounts in publications. The average of all TPCC results was 0.808, and the accounts @govpt, @defesa_pt, and @saude_pt pages were positioned above them. The remaining accounts could be considered under the average and, therefore, low levels of the TPCC index. For a compact, at-a-glance overview of per-account values (transparency, participation, collaboration, comfort, and TPCC),

please see the Appendix C tables. To avoid duplicating content and keep the main text concise, we direct readers to the full per-account breakdown.

Table 15. TPCC index results.

Accounts	TPCC Index
govpt	1.938
defesa_pt	1.366
saude_pt	0.839
ciencia_pt	0.778
cultura_pt	0.727
trabalho_pt	0.656
justica_pt	0.632
ieistruturas_pt	0.628
nestrangeiro_pt	0.619
agricultura_pt	0.607
educacao_pt	0.601
ambiente_pt	0.594
planeamento_pt	0.529
ainterna_pt	0.418

Moreover, the official government account @govpt presented a higher TPCC index than twelve Arab countries' Facebook accounts that underwent the same analysis by [22], where Abu Dhabi (1647) and Bahrain (1278) presented the highest indexes.

The low frequency of posts, averaging 3.92 per day, was the greatest hindrance to communication success and a higher average of the TPCC Index. Analyzing the public metrics for the @govpt account (exploratory analysis), all posts that ranked higher on retweets, likes, quotes, and replies contained a link or multimedia resource, which was already pointed out as a primary driver of engagement and should be considered an essential factor in the planning of a social media strategy for the Portuguese government. Rankings are primarily driven by (i) account lifespan/volume (affecting transparency metrics), (ii) link usage shares (comfort), and (iii) polls/co-creation prompts (participation/collaboration). Earlier-created, consistently active accounts (@govpt, @defesa_pt) score higher. For within-sample comparisons, we classify TPCC using sample quartiles: Q1 = "low", Q2 = "moderate-", Q3 = "moderate+", Q4 = "high." These bands are descriptive (not absolute thresholds). Cross-study comparisons should adjust for platform and time period.

The results of the collaboration and participation factors displayed a preference for engagement over co-creation terms. However, both categories were more frequently employed than participative terms, which suggests that the Portuguese government did not utilize X as a trusted channel for surveys, inquiries, or information collection. This prevalence suggested that the Portuguese government fits Level 3 of the maturity model proposed by [55]. The maturity level is directly related to the level of effort from the public sector to collaborate and involve citizens more deeply in its processes. It has not yet reached Level 4, which is Open Collaboration, and this is common in public sector accounts [10,50].

The exploratory analysis, developed over the @govpt account, used the main methods existing for X analytics and enabled a detailed summary of the Portuguese government practices, partly because this account represented an essential origin of the content and central point of interaction for all other accounts; therefore, comprehending how this

account behaves, we can determine all other accounts' activities. The time series analysis depicted that though the X account was created in 2009, it was only actively used from 2016 onwards.

While the results from the linguistic analysis presented on WordCloud and topic modeling showed the low adoption of terms outside of the governmental sphere, suggesting the Portuguese government used social media for its informational aspect rather than as a communication or collaboration channel. This fact aligned with the habit of the Portuguese population of using social media to consume and not to interact, which leads to low numbers of followers, engagement metrics, and interest in these accounts, which is worsened by the low frequency of posts and leads to low levels of transparency, participation, collaboration, and comfort.

The engagement-enabling features identified in this study remain modest. The higher TPCC relative to prior Facebook-based studies reflects different platforms/periods and metric compositions; we therefore interpret results as relative rather than absolute success.

At a glance, transparency and comfort are consistently the strongest dimensions across accounts, while participation and collaboration are comparatively less developed; accordingly, differences in overall TPCC are primarily explained by account longevity/volume and the frequency of link-sharing and interactive content. See Appendix B for the exact per-account figures.

5. Conclusions

Many countries, including Portugal, have adopted the Open Government principles and are taking the proper steps toward a more transparent, participative, and collaborative governance. However, they still face several challenges in consolidating innovation in their communication on more specific and general terms of digital adaptation. This research is the first to investigate the communication facet of this problem in Portugal and resulted in a complete profile of the communication process, with the identification of patterns and missteps.

This study's main objective was to comprehend the theoretical concepts governments had at hand to guide their interactions with citizens in the digital era. This question is addressed through the presentation of Open Government principles, followed by the identification of 31 resources to achieve these principles, as they are connected to the goals of social media use in the public sector. In that sense, the TPCC index proved to be a valuable measure of the adoption in governmental accounts.

It is unclear if there are norms regarding how the analyzed agencies should behave online. Still, due to similarities in the topics and content types, it is possible to imply a pattern in all accounts, which depicts joined efforts from agencies and the government to enhance the interaction with citizens. Although it was possible to visualize the evolution in the use of social media by the Portuguese government, some aspects of the Portuguese government and society hindered the success of this communication. Some of these factors include the old-fashioned manners of governing and processes, the nature of the population's use of social media for content consumption rather than interaction, and the prevalence of other communication channels such as radio and television.

The exploratory analysis helped determine critical characteristics of the Portuguese government's X communication: low and almost inadequate frequency of publications; preformatted post styles, focused on informing about the government's day-to-day activities rather than engaging in conversations with the citizens; low use of essential resources such as videos, links, and connections to other social media platforms; little diversity on posted topics over time; no connections with external accounts while also presenting a low number of connections with internal accounts.

The second part was the application of the TPCC index calculations proposed by [22], resulting in a “grade” for each of the four factors. This research successfully validated such calculations for X due to changes in the criteria proposed initially for Facebook. Moreover, although there is a lack of comparison for these measurements, it is possible to make more general assumptions about the quality of communication being put into practice by the agencies and identify the most significant challenges.

5.1. Theoretical Contributions

The present study contributes to the existing research on social media use by the public sector and, more specifically, analysis of governmental activity on X to build on previous studies [22,78,79]. In the development of this research, the focus of the analysis was the Portuguese case study, selecting different subjects from the governmental scope to provide a comprehensive critical analysis of the topic.

As the studies suggest, effective social media strategies for governmental purposes revolve around perceptions of transparency, participation, and collaboration in society. In other words, modern governance involves citizens in every decision-making step, keeping them informed and engaged in conversations.

Above all, the main contributions of this research are situated in the Portuguese case study and the application of the TPCC Index methodology. First, it reinforces the notions about the Portuguese situation, given that the literature on this subject is scarce and previous studies focused either on the political aspect [64] or the user characteristics [16] creating a gap in the governmental angle of the matter. Secondly, a central theoretical contribution of this study is the adaptation of the TPCC index, initially developed for Facebook, to the platform X (formerly Twitter). This methodological innovation expands the applicability of the TPCC framework to different social media environments and provides a foundation for cross-platform and cross-country comparisons of governmental communication success.

5.2. Managerial Implications

In practical terms, the present research aimed to identify patterns and problems within public digital communication in Portugal and develop a deeper understanding of the critical factors influencing the public sector’s use of social media. Under the framework presented in the research, four principles explain the relevance and purpose of communicating online with citizens: transparency, participation, collaboration, and comfort. Close monitoring of all metrics related to these principles and their incorporation in the government’s communication planning proved essential to establishing successful and meaningful interactions.

For policymakers, this TPCC adaptation provides a replicable and auditable method to evaluate the effectiveness of governmental communication strategies on X. It allows governments to benchmark their performance and identify areas of improvement in transparency, participation, collaboration, and comfort. For scholars, the approach demonstrates how platform-specific adaptations of established indices can enrich comparative research and build cumulative knowledge in public communication studies.

The Portuguese case in this research highlighted the need to enhance various aspects of X communication to address issues like low engagement and interest in the accounts. The main identified issue was the low frequency of tweet posting, which is exacerbated by social media algorithms that determine what each user sees, thereby amplifying the reach of content from accounts that post regularly. Therefore, it is essential to maintain a high average of daily posts to stimulate interactions and create space for content diversification.

Another problem identified was the use of a template for most tweets in the sample, as the repetition of the tweet structure discourages citizens from interacting with it. This

issue could be solved by using dynamic resources more frequently on posts, such as videos and broadcasts, instead of images, the leading multimedia resource. Besides implementing different types of content, the messages should be more engaging. The low level of collaborative and participative terms demonstrated this fact.

In conclusion, the last point of change for the Portuguese government towards successful communication on X is the element of network and conversation between different accounts and pages, which is nonexistent in the tweets analyzed. Raising the number of interactions with other accounts, especially outside of the governmental scope, and adopting techniques to answer the feedback presented by citizens could be other valuable forms to improve the account's results.

5.3. Limitations and Recommendations for Future Research

Every research development is accompanied by limitations that sometimes lead to alternative paths. In the present study, the most significant limitation and, at the same time, motivation for the study was the research gap. Research has shown that there is a lack of interest in studies about the public sector, primarily due to the uncertainty of financial gains and the government's limited investment in public development.

Moreover, the choice of the subjects for the analysis was also limited by a common problem: the small sample size due to the low activity on the Portuguese government accounts. For that matter, the decision to extend the timeframe of the data was taken. Although this achieved a good representation, as all available data were collected, it also became harder to obtain good insights, leading to the split of the sample for different analyses.

We note the well-known pitfalls of social media analytics. Activity is not influence. High posting frequency or raw engagement counts do not necessarily reflect persuasive power, reach into relevant publics, or policy impact; similarly, posting volume is only weakly coupled with meaningful engagement. Simple aggregates are easy to over-interpret, so we read TPCC as a descriptive benchmark of observable behaviors, not a causal estimate of impact.

Given non-independence of posts within accounts and unequal account lifespans, we treat TPCC as a descriptive benchmarking tool and refrain from between-account significance tests. This limitation could be addressed in future studies using account-level bootstrapping.

Another limitation is the temporal validity, which can produce confounding factors. The platform/policy changes post-2022, and the study provides a historical baseline rather than a real-time dashboard. Also, the covered period includes COVID-19, which likely altered posting and audience behavior. Future studies should analyze the behavior of these accounts, both before and after platform changes.

Additionally, for future studies, the recommendations would be to explore specific aspects of Portuguese government communication, such as economics, education, and health, while also measuring public engagement and contributing to understanding how the Portuguese people interact with these accounts. The development of further pattern recognition regarding engagement can help understand the topics, people's responses to them, and the use of replies and quotes data to detect and analyze the conversational facet of social media communication.

Another element that requires further development is the measurement methods, such as the TPCC index. The further development of studies and analytical models that implement such calculations creates an environment for comparative and global indexation of public digital communication. The public sector's lack of awareness about these methods contributes to the low number of productions and the limited attention to

how the government can better engage with citizens and leverage social media features to enhance trust and democratic processes.

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Data Availability Statement: Tweet IDs, account list, and account-level aggregates are available in an anonymized public repository (contact authors to obtain access. Raw tweet text is not redistributed per the platform’s Terms of Service.

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Abbreviations

The following abbreviations are used in this manuscript:

MAI Internal Administration Ministry
TPCC Transparency, Participation, Collaboration, and Comfort

Appendix A.

Table A1. Sample description.

Account	Agency
agricultura_pt	Ministry of Agriculture
ainterna_pt	Ministry of Internal Administration
ambiente_pt	Ministry of the Environment
ciencia_pt	Ministry of Sciences
cultura_pt	Ministry of Culture
defesa_pt	Ministry of Defense
educacao_pt	Ministry of Education
iestruturas_pt	Ministry of Infrastructures
justica_pt	Ministry of Justice
nestrageiros_pt	Ministry of External Affairs
planeamento_pt	Ministry of Planning
saude_pt	Ministry of Health
trabalho_pt	Ministry of Labour

Appendix B.

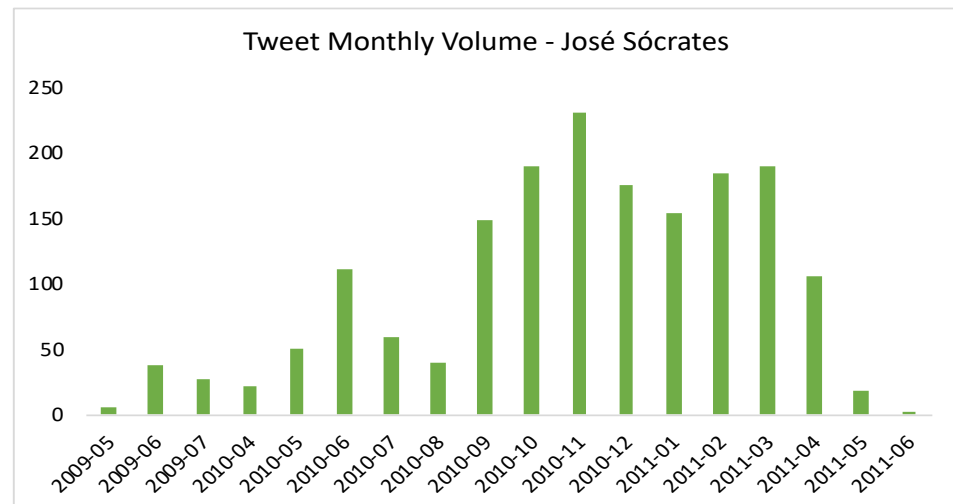


Figure A1. Tweet monthly volume of @govpt account by mandate—José Sócrates.

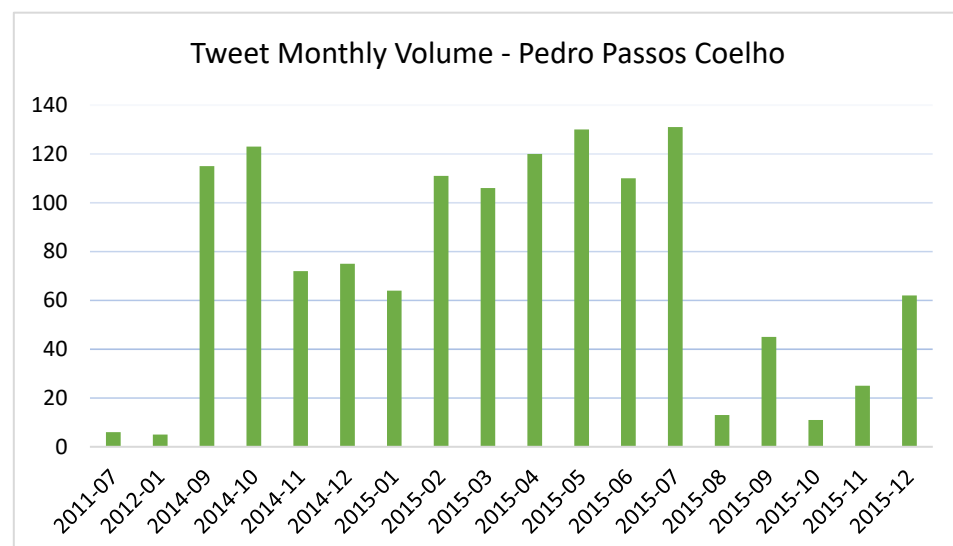


Figure A2. Tweet monthly volume of @govpt account by mandate—Pedro Passos Coelho.

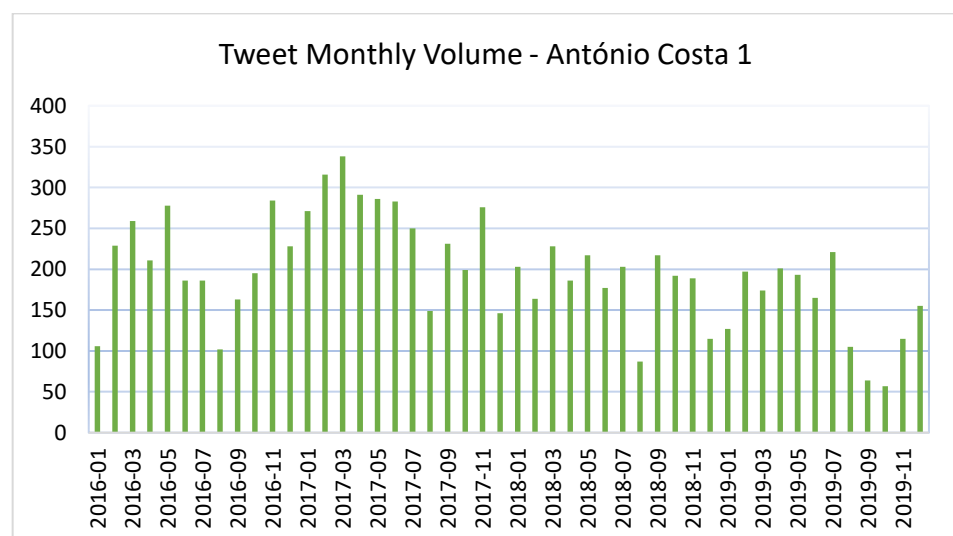


Figure A3. Tweet monthly volume of @govpt account by mandate—António Costa 1.

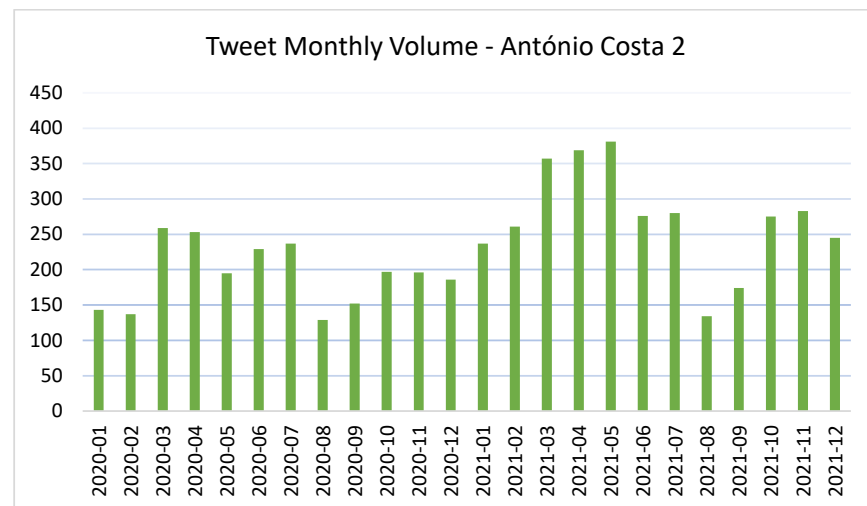


Figure A4. Tweet monthly volume of @govpt account by mandate—António Costa 2.

Appendix C.

Appendix C consolidates, in one place, the per-account values for the four sub-indices and the overall TPCC for quick reference.

Table A2. TPCC index results for Arabic countries by [22]. Transparency Index for Arabic countries.

#	Country	Transparency Index
1	Tunisia	0.62
2	Abu Dhabi	0.58
3	Bahrain	0.32
4	Jordan	0.27
5	Kuwait	0.24
6	Palestine	0.23
7	Qatar	0.11
8	Oman	0.11
9	Morocco	0.11
10	Saudi Arabia	0.06
11	Egypt	0.04
12	Libya	0.01

Table A3. TPCC Index results for Arabic countries by [22]. Participation Index for Arabic countries.

	Country	Participation Index
1	Oman	0.59
2	Egypt	0.50
3	Abu Dhabi	0.50
4	Kuwait	0.30
5	Qatar	0.25
6	Bahrain	0.25
7	Jordan	0
8	Saudi Arabia	0
9	Palestine	0
10	Morocco	0
11	Tunisia	0
12	Libya	0

Table A4. TPCC Index results for Arabic countries by [22]. Collaboration Index for Arabic countries.

#	Country	Collaboration Index
1	Qatar	0.75
2	Bahrain	0.50
3	Kuwait	0.50
4	Egypt	0.50
5	Palestine	0.50
6	Oman	0.30
7	Jordan	0.25
8	Abu Dhabi	0.10
9	Saudi Arabia	0.10
10	Morocco	0.10
11	Tunisia	0
12	Libya	0

Table A5. TPCC Index results for Arabic countries by [22]. Comfort Index for Arabic countries.

#	Country	Comfort Index
1	Abu Dhabi	0.34
2	Tunisia	0.19
3	Bahrain	0.14
4	Jordan	0.08
5	Palestine	0.07
6	Qatar	0.05
7	Saudi Arabia	0.04
8	Oman	0.03
9	Egypt	0.02
10	Morocco	0.015
11	Lybia	0.004
12	Kuwait	0

Table A6. TPCC Index results for Arabic countries by [22]. TPCC Index for Arabic countries.

#	Country	TPCC Index
1	Abu Dhabi	1.647
2	Bahrain	1.278
3	Qatar	1.190
4	Oman	1.063
5	Tunisia	0.946
6	Jordan	0.657
7	Kuwait	0.647
8	Egypt	0.625
9	Palestine	0.402
10	Morocco	0.248
11	Saudi Arabia	0.180
12	Libya	0.018

References

- Nicolò, G.; L'Abate, V.; Raimo, N.; Vitolla, F. Substantive versus symbolic paths in SDG disclosure via social media: Evidence from Italian local governments. *Public Money Manag.* **2024**, *45*, 744–752. [CrossRef]
- Nadzir, M.; Othman, N.; Awang, N. Factors influencing citizens' engagement in e-government 2.0. *J. Theor. Appl. Inf. Technol.* **2020**, *98*, 245–255.
- Tan, E.; Dan, S.; Shahzad, K. Guest editorial: Bridging the chasm between “what could be” and “what is”: The impact of blockchain technologies on public service management. *Int. J. Public Sect. Manag.* **2025**, *38*, 1–11. [CrossRef]
- Mishaal, D.; Abu-Shanab, E. The Effect of Using Social Media in Governments: Framework of Communication Success. In Proceedings of the 7th International Conference on Information Technology ICIT '15, Amman, Jordan, 12–15 May 2015; pp. 357–364.
- Shen, C.; Xu, Y.; Yuan, Z. Digital dialogue in smart cities: Evidence from public concerns, government responsiveness, and citizen satisfaction in China. *Cities* **2025**, *158*, 105717. [CrossRef]
- Lovari, A.; Valentini, C. Public Sector Communication and Social Media: Opportunities and Limits of Current Policies, Activities and Practices. In *Handbook of Public Sector Communication*; Luoma-aho, V., José Canel, M., Eds.; Wiley: Hoboken, NJ, USA, 2019; pp. 315–328.
- Li, Y.; Kapucu, N. Determinants of the use of social media in crisis communication: An analysis of microblogging by Chinese local government. *Int. J. Public Adm.* **2025**, *48*, 100–114. [CrossRef]
- Schillemans, T.; Overman, S.; Flinders, M.; Laegreid, P.; Maggetti, M.; Papadopoulos, Y. Wood MPublic sector accountability styles in Europe: Comparing accountability control of agencies in the Netherlands Norway Switzerland the, U.K. *Public Policy Adm.* **2024**, *39*, 125–146. [CrossRef]
- Kotler, P.; Lee, N. *Social Marketing: Influencing Behaviors for Good*; Sage: Thousand Oaks, CA, USA, 2008.
- Hofmann, S.; Beverungen, D.; Rackers, M.; Becker, J. What makes local governments' online communications successful? Insights from a multi-method analysis of Facebook. *Gov. Inf. Q.* **2013**, *30*, 387–396. [CrossRef]
- Buyens, W.; Van Aelst, P.; Paulussen, S. Curating the news: Analyzing politicians' news sharing behavior on social media in three countries. *Inf. Commun. Soc.* **2024**, *28*, 1351–1367. [CrossRef]
- Giger, N.; Bailer, S.; Sutter, A.; Turner-Zwinkels, T. Policy or person? What voters want from their representatives on X. *Elect. Stud.* **2021**, *74*, 102401. [CrossRef]
- Afonso, F.; Rita, P.; António, N. Using candidates' tweets to predict an election outcome. *Political Res. Q.* **2025**, *78*, 323–340. [CrossRef]
- Rebelo, I.; Felício, L.; Rodrigues, M.; Magalhães, M.; Teixeira, R. O X como estratégia mediática para a chegada de novos partidos à Assembleia da República portuguesa. *Prisma. Com.* **2020**, *43*, 62–82.
- Lapa, T.; Vieira, J. Digital divides in Portugal and Europe. Is Portugal still chasing the European train? *Sociol. Online* **2019**, *21*, 62–82.
- Carvalho, D.; Daniel, A.C. As redes sociais e a Administração Pública. *Gestin* **2016**, *12*, 135–147.
- DataReportal (2021): “Digital 2021: Portugal”. Available online: <https://datareportal.com/reports/digital-2021-portugal> (accessed on 7 November 2022).
- Matei, A.; Bujac, R. Innovation and Public Reform. *Procedia Econ. Financ.* **2016**, *39*, 761–768. [CrossRef]
- Chen, S.; Yuan, X.; Wang, Z.; Guo, C.; Liang, J.; Wang, Z.; Zhang, X.; Zhang, J. Interactive Visual Discovery of Movement Patterns from Sparsely Sampled Geo-tagged Social Media Data. *IEEE Trans. Vis. Comput. Graph.* **2020**, *22*, 270–279. [CrossRef] [PubMed]
- Hubert, R.; Estevez, E.; Maguitman, A.; Janowski, T. Examining Government-Citizen Interactions on X using Visual and Sentiment Analysis. In Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age, Delft, The Netherlands, 30 May–1 June 2018.
- O'Neil, C.; Schutt, R. *Doing Data Science*; O'Reilly Media: Sebastopol, CA, USA, 2013.
- Mishaal, D.; Abu-Shanab, E. Utilizing Facebook by the Arab World Governments: The Communication Success Factor. *Int. J. Public Adm. Digit. Age* **2017**, *4*, 357–364. [CrossRef]
- Peters, K.; Chen, Y.; Kaplan, A.; Ognibeni, B.; Pauwels, K. Social Media Metrics—A Framework and Guidelines for Managing Social Media. *J. Interact. Mark.* **2013**, *27*, 281–298. [CrossRef]
- Kaplan, A.M.; Haenlein, M. Users of the world, unite! The challenges and opportunities of Social Media. *Bus. Horiz.* **2010**, *53*, 59–68. [CrossRef]
- Treem, J.; Leonardi, P. Social Media Use in Organizations: Exploring the Affordances of Visibility, Editability, Persistence and Association. *Commun. Yearb.* **2012**, *36*, 143–189. [CrossRef]
- Lawrence, R.; Melville, P.; Perlich, C.; Sindhwani, V.; Meliksetian, S.; Hsueh, P.; Liu, Y. Social Media Analytics. *OR MS Today* **2010**, *37*, 26–30.
- Zafarani, R.; Abbasi, M.; Liu, H. *Social Media Mining: An Introduction*, 1st ed.; Cambridge University Press: Cambridge, UK, 2014.
- Zeng, D.; Chen, H.; Lusch, R.; Li, S. Social Media Analytics and Intelligence. *IEEE Intell. Syst.* **2010**, *25*, 13–16. [CrossRef]

29. Gonçalves, A. *Social Media Analytics Strategy*; Apress: Berkeley, CA, USA, 2017.
30. Stieglitz, S.; Mirbabaie, M.; Ross, B.; Neuberger, C. Social Media Analytics: Challenges in topic discovery, data collection, and data preparation. *Int. J. Inf. Manag.* **2018**, *39*, 156–168. [CrossRef]
31. Stieglitz, S.; Bruns, A. Towards More Systematic X Analysis: Metrics for Tweeting Activities. *Int. J. Soc. Res. Methodol.* **2014**, *16*, 91–108.
32. Fan, W.; Gordon, M. The Power of Social Media Analytics. *Commun. ACM* **2014**, *57*, 74–81. [CrossRef]
33. Wu, G.; Xu, Z.; Tajdini, S.; Zhang, J.; Song, L. Unlocking value through an extended social media analytics framework: Insights for new product adoption. *Qual. Mark. Res.* **2019**, *22*, 161–179. [CrossRef]
34. Jung, S.H.; Jeong, Y.J. X data analytical methodology development for prediction of start-up firms' social media marketing level. *Technol. Soc.* **2020**, *63*, 101409. [CrossRef]
35. Statista: Number of Monthly Active X Users Worldwide from 1st Quarter 2010 to 1st Quarter 2019. 2022. Available online: <https://www.statista.com/statistics/282087/number-of-monthly-active-x-users> (accessed on 29 July 2025).
36. O'Leary, D. *Intelligent Systems in Accounting, Finance and Management*; Wiley: Los Angeles, CA, USA, 2015.
37. Irfan, R.; King, C.; Grages, D.; Ewen, S.; Khan, S.; Madani, S.; Kolodziej, J.; Wang, L.; Chen, D.; Rayes, A.; et al. A Survey on Text Mining in Social Networks. *Knowl. Eng. Rev.* **2015**, *30*, 157–170. [CrossRef]
38. Kumar, S.; Morstatter, F.; Liu, H. *X Data Analytics*; Springer Science & Business Media: New York, NY, USA, 2013.
39. Burghardt, M. Introduction to Tools and Methods for the Analysis of X Data. *10plus1 Living Linguist.* **2015**, *1*, 74–91.
40. Vieweg, S.; Hughes, A.; Starbird, K.; Palen, L. Microblogging During Two Natural Hazards Events: What X May Contribute to Situational Awareness. In Proceedings of the 28th International Conference on Human Factors in Computing Systems, Atlanta, GA, USA, 23–28 April 2010.
41. Mandel, B.; Culotta, A.; Boulahanis, J.; Stark, D.; Lewis, B.; Rodrigues, J. A demographic analysis of online sentiment during Hurricane Irene. In Proceedings of the Second Workshop on Language in Social Media, Stroudsburg, PA, USA, 12–21 June 2012.
42. Nguyen, T.; Koshikawa, K.; Kawamura, T.; Tahara, Y.; Ohsuga, A. Building earthquake semantic network by mining human activity from X. In Proceedings of the IEEE International Conference on Granular Computing, Piscataway, NJ, USA, 8–10 November 2011; pp. 496–501.
43. Singh, P.; Dwivedi, Y.; Kahlon, K.; Pathania, A.; Singh, S. Can X analytics predict election outcome? An insight from 2017 Punjab assembly elections. *Gov. Inf. Q.* **2020**, *37*, 101444. [CrossRef]
44. Burnap, P.; Gibson, R.; Sloan, L.; Southern, R.; Williams, M. 140 characters to victory?: Using X to predict the UK 2015 General Election. *Elect. Stud.* **2016**, *41*, 230–233. [CrossRef]
45. Devika, M.; Sunitha, C.; Ganesh, A. Sentiment Analysis: A Comparative Study on Different Approaches. *Procedia Comput. Sci.* **2016**, *87*, 44–49. [CrossRef]
46. Chae, B. Insights from hashtag #supplychain and X Analytics: Considering X and X data for supply chain practice and research. *Int. J. Prod. Econ.* **2015**, *165*, 247–259.
47. Singh, P.; Dwivedi, Y.; Kahlon, K.; Sawhney, R. Intelligent Monitoring and Controlling of Public Policies Using Social Media and Cloud Computing. In *Proceedings of the Smart Working, Living and Organising: IFIP WG 8.6 International Conference on Transfer and Diffusion of IT, TDIT 2018, Portsmouth, UK, June 25, 2018*; Elbanna, A., Dwivedi, Y.K., Bunker, D., Wastell, D., Eds.; Springer: Cham, Switzerland, 2018; pp. 143–154.
48. Matheus, R.; Janssen, M.; Janowski, T. Design principles for creating digital transparency in government. *Gov. Inf. Q.* **2021**, *38*, 101550. [CrossRef]
49. Bertot, J.; Jaeger, P.; Grimes, J. Using ICTs to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies. *Gov. Inf. Q.* **2010**, *27*, 264–271. [CrossRef]
50. Vos, M.; Westerhoudt, E. Trends in government communication in the Netherlands. *J. Commun. Manag.* **2008**, *12*, 18–29. [CrossRef]
51. Song, C.; Lee, J. Citizens' Use of Social Media in Government, Perceived Transparency, and Trust in Government. *Public Perform. Manag. Rev.* **2016**, *39*, 430–453. [CrossRef]
52. Eggers, W. *Government 2.0*; Rowman & Littlefield Publishers: Lanham, MD, USA, 2007.
53. Khan, G. The Government 2.0 utilization model and implementation scenarios. *Inf. Dev.* **2013**, *31*, 135–149. [CrossRef]
54. Wirtz, B.; Weyerer, J.; Rosch, M. Open government and citizen participation: An empirical analysis of citizen expectancy towards open government data. *Int. Rev. Adm. Sci.* **2017**, *85*, 566–586. [CrossRef]
55. Lee, G.; Kwak, Y.H. An Open Government Maturity Model for social media-based public engagement. *Gov. Inf. Q.* **2012**, *29*, 492–503. [CrossRef]
56. Sixto-Garcia, J. Uso de las redes sociales en la Administración pública gallega: ¿una técnica de marketing 2.0? *Pensar La Public* **2012**, *6*, 345–363. [CrossRef]
57. Cho, W.; Melisa, W. Citizen Coproduction and Social Media Communication: Delivering a Municipal Government's Urban Services through Digital Participation. *Adm. Sci.* **2021**, *11*, 59. [CrossRef]

58. Gonçalves, J.; Liu, Y.; Xiao, B.; Chaudhry, S. Modeling Government–Citizen Interaction on Facebook. *Policy Internet* **2015**, *7*, 80–102.
59. Guerreiro, S.; Pereira, F. O que caracteriza os Portugueses nas comunidades online em Portugal. *Comun. Pública* **2012**, *7*, 91–116. [CrossRef]
60. Sousa, J.; Morais, R. A mobilização cívica e política na era das redes sociais: Uma análise da ação de movimentos sociais no Facebook. *Opinião Pública* **2021**, *27*, 51–89. [CrossRef]
61. Santos, H. A Comunicação Política do XVII Governo de Portugal. In Proceedings of the 4º Congresso SOPCOM, Porto, Portugal, 5–6 May 2005; pp. 677–690.
62. Correia, J. Governos e Media: O Triunfo da Mediatização Política e a Autonomia do Jornalismo. *Rev. Media E J.* **2011**, *17*, 145–155.
63. Paulino, F.; Guazina, L.; Oliveira, M. Serviço público de média e comunicação pública: Conceito, contextos e experiências. *Comun. E Soc.* **2016**, *30*, 55–70. [CrossRef]
64. Brás, R. Reflexões sobre a utilização política das redes sociais em Portugal. *Int. Bus. Econ. Rev.* **2015**, *6*, 300–334.
65. Gonçalves, G.; Piñeiro-Naval, V.; Toniolo, B. Em quem confiam os portugueses? A Gestão da Comunicação Governamental na Pandemia de Covid-19. *Comun. E Soc.* **2021**, *40*, 169–187.
66. Padeiro, M.; Bueno-Larraz, B.; Freitas, A. Local governments’ use of social media during the COVID-19 pandemic: The case of Portugal. *Gov. Inf. Q.* **2021**, *38*, 101620. [CrossRef]
67. Dominic, D.; Gisip, I. Effect of Social Media Usage in Government Agencies’ Communication Effort. *Int. J. Acad. Res. Bus. Soc. Sci.* **2021**, *11*, 1452–1467. [CrossRef]
68. McKinney, W. Data structures for statistical computing in Python. *Scipy* **2010**, *445*, 51–56.
69. Seltman, H. *Experimental Design and Analysis*; Carnegie Mellon University: Pittsburgh, PA, USA, 2012.
70. Brockwell, P.; Davis, R. *Introduction to Time Series and Forecasting*; Springer: New York, NY, USA, 2016.
71. Hunter, J.D. Matplotlib: A 2D Graphics Environment. *Comput. Sci. Eng.* **2007**, *9*, 90–95. [CrossRef]
72. Stieglitz, S.; Dang-Xuan, L. Social media and political communication: A social media analytics framework. *Soc. Netw. Anal. Min.* **2013**, *3*, 1277–1291. [CrossRef]
73. Fairbanks, J.; Plowman, K.; Rawlins, B. Transparency in Government Communication. *J. Public Aff.* **2007**, *7*, 23–37. [CrossRef]
74. Gordon, T. *E-Government—Introduction*; ERCIM News: Sophia Antipolis, France, 2002; p. 48.
75. Nadzir, M.; Harun, N.; Hassan, M. Social Media engagement on Malaysian government agencies’ Facebook pages: An empirical analysis. In Proceedings of the 2019 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology, Amman, Jordan, 9–11 April 2019; pp. 717–719.
76. TicTank. O novo Governo é o Mais Digital. 2019. Available online: <https://tictank.pt/2019/10/29/novo-governo-e-o-mais-digital/> (accessed on 5 May 2022).
77. Soares, M.; Barbosa, M.; Matos, R.; Mendes, S.M. Public protest and police violence: Moral disengagement and its role in police repression of public demonstrations in Portugal. *Peace Confl. J. Peace Psychol.* **2018**, *24*, 27. [CrossRef]
78. Mergel, I. A framework for interpreting social media interactions in the public sector. *Gov. Inf. Q.* **2013**, *30*, 327–334. [CrossRef]
79. Criado, I.; Villodre, J. Delivering public services through social media in European local governments. *Local Gov. Stud.* **2020**, *27*, 1–23.

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