FROM POSTS TO VOTES: USING XLM-RoBERTa (XLM-R) TO ANALYZE SOCIAL MEDIA AS AN INDICATOR OF PRESIDENTIAL ELECTION WINS FOR THE PHILIPPINES AND UNITED STATES

A Thesis

Presented to the

Department of Information Systems

and Computer Science

Ateneo de Manila University

In Partial Fulfillment

of the Requirements for the Degree of

Bachelor of Science in Computer Science

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2026

ABSTRACT

Recent election periods have seen the rise of social media platforms as tools through which political ideologies are spread, and support for candidates are garnered. Despite widespread support in online spaces, however, former vice presidents Maria Leonor "Leni" Robredo and Kamala Devi Harris lost their respective presidential elections in 2022 (in the Philippines) and 2024 (in the United States) to Ferdinand “Bongbong” Marcos Jr. and Donald John Trump. The main motivation for this research is to determine the effectiveness of social media as an indicator of electoral wins. Through the Robustly Optimized BERT Pre-Trained Approach (RoBERTa) and other NLP techniques, this paper aims to perform sentiment analysis on posts from X (formerly Twitter), a popular social media platform when it comes to discussing politics for both countries, to draw insights on how citizens perceived both the winning and first runner-up electoral candidates during pre- and proper election periods and compare these perceptions to the results of each presidential election.

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CHAPTER I

INTRODUCTION

1.1 Context of Study

In recent decades, social media has had a major role as a platform through which political ideologies are spread and political discussions occur. This is especially apparent when observing the flow of recent elections in certain countries. In the Philippines, the 2016 Philippine presidential election is widely considered the first "social media election" in the Philippines, mainly due to how its winner, Rodrigo Roa Duterte, was able to utilize social media to establish a controversial image which mobilized his wide follower-base to rally in support of him, both online and offline [35]. Meanwhile, social media proved to be a crucial element in Joseph Robinette "Joe" Biden Jr.'s 2020 election win in the United States. Through an "influencer campaign", Biden was able to reach out to young audiences on social media, particularly those of generation Z, which then translated to a massive voter turnout in that certain demographic [36].

In other elections, however, cases have occurred in which online support did not directly translate to election wins. One of the most prominent examples of the importance of social media in world politics is former United States (US) Vice

President Kamala Harris' social media campaign for the 2024 US presidential elections. Mainly targeting younger audiences through viral "memes" and other social media trends, Harris was able to amass widespread support for her campaign, having just over 5 million followers supporting her endeavors on TikTok and X (formerly Twitter) combined [22]. Similarly, the 2022 Philippine elections saw the Angat Buhay campaign of former Vice President Leni Robredo. Similarly to Harris, Robredo was able to garner the attention of young audiences on social media. Rallies in support of Robredo alongside Robredo's track record as a politician made her a popular choice for millions as a capable presidential candidate [19].

Despite massive online support, both Harris and Robredo had lost their respective elections, the former only garnering 226 electoral votes (against Donald Trump's 312 votes) and the latter garnering some 14.8 million votes (as opposed to Ferdinand "Bongbong" Marcos, Jr, who gathered 31.1 million) [1, 7]. Given a possible disparity between social media popularity and election votes, the aim of this research is to provide a data-driven analysis on the effectiveness of social media as an indicator of election wins by observing social media trends at the time of both 2022 and 2024 elections, as well as comparing and contrasting these elections in terms of said trends.

Through Natural Language Processing (NLP) Algorithms, this paper

aims to analyze the conversations on the aforementioned presidential candidates that had transpired in online spaces during pre-election seasons, namely X (formerly Twitter). Previous research endeavors have already shown the effectiveness of sentiment analysis in determining key themes behind social media posts, especially in the context of events such as elections. Thus, this research would like to push this idea further by not only contextualizing the data within a single setting. Rather, this paper aims to compare and contrast the election periods of the Philippines and US, given that, as already mentioned, the two countries experienced a supposed upset in terms of electoral candidate votes relative to their presence on social media.

This paper intends to provide a thorough a comparative study analysis between the 2022 Philippine presidential election campaigns of candidates Ferdinand "Bongbong" Marcos and Leni Robredo, with their respective running mates Sara Duterte and Francis "Kiko" Pangilinan, and the 2024 US presidential election campaigns of candidates Donald Trump and Kamala Harris, with their respective running mates James "JD" Vance and Timothy Walz. This research also aims to determine whether or not social media support directly translates to election success, or if other factors were present which had contributed to the losses of Harris and Robredo in their respective runs for presidency.

1.2 Research Questions

1. The RoBERTa model can be used for sentiment analysis on social media posts. How can it be used to compare and contrast the two elections between two countries, the Philippines and the USA, in terms of social media activity?

   (a) What are the sentiments and texts RoBERTa captured from Philippine social media users as opposed to US social media users?

   (b) How do the different themes, frequencies, and sentiments of keywords and phrases expressed by users on X (formerly Twitter) indicate their support for the candidates and a candidate's electoral win?

   (c) What are the similarities and differences, if there are any, between the results and findings from the RoBERTa model for the Philippines and United States?

   (d) How can social media presence throughout the two elections (Marcos Jr. vs. Robredo in the 2022 Philippine elections; and Trump vs. Harris in the 2024 US elections) be visualized to show concise and understandable information to the general public?

1.3 Research Objectives

1. Natural Language Processing (NLP) techniques can be used for sentiment analysis on social media posts. For this paper, NLP and RoBERTa are being tested on its ability to predict election outcomes.

    (a) Capture the frequency of the sentiments and texts shared by Philippine social media users and US social media users.

    (b) Determine the sentiments shared by users on X (formerly Twitter) towards the candidates and whether or not these sentiments indicate their support and a candidate's electoral win.

    (c) Compare the conclusions of the first two objectives with one another to reaffirm the consistency and accuracy of the algorithm's output for both analyzed elections.

    (d) Develop a dashboard providing a comprehensive overview of social media sentiments in relation to election results by comparing results drawn from sentiment analysis algorithms and actual election results.

1.4 Scope and Limitations of the Study

This paper is a case study on two presidential elections that have most prominently used social media as part of their campaign strategies, with data

extracted each from the Philippines and the United States. To add to the discussion, social media data about each president's respective vice presidential running mate candidate will be considered as well. As such, this is a case study analysis comparing the recent 2022 Philippine presidential election, with leading candidates Marcos-Duterte and Robredo-Pangilinan against the recent 2024 US presidential election, with leading candidates Trump-Vance and Harris-Walz. The paper aims to analyze how the respective campaign periods of each candidate (and their running mates) were reflected on different social media spaces. This is to determine the effectiveness of social media platforms as indicators of electoral wins and determine whether electoral results can be foreseen based on online traction and popularity.

This paper will focus only on the social media platform X (formerly Twitter) in data collection due to their popularity within the United States and the Philippines. Only posts made after the announcement of a candidate's intention to run for president and prior to the actual election days will be collected, as the goal is to compare pre-election social media data to post-election results. It is also worth mentioning that, for all elections under the scope of this study, only the winner and first-runner up will be considered as collecting enough data on all candidates might not be feasible [26]. As such, with reference to the dates of when each leading candidates announced their intention to run, the paper

will only consider posts made after October 7, 2021 for Robredo and October 5, 2021 for Marcos in the 2022 Philippine presidential election, and July 21, 2024 for Harris and November 15, 2022 for Trump in the 2024 US presidential election [21, 9, 37, 28]. Posts made 2 days before the election dates and beyond will be excluded from the study. *"Posts"* include any and all publicly available posts made by the general public on the selected candidates salongside any posts made by the candidates themselves; however, data on the users who made the posts themselves, such as gender or location, will not be considered due to the lack of availability.

Finally, attached to the names of some candidates are certain criminal cases. The Marcos Family was responsible for a series of atrocities and human rights violations in the 1970s, and Trump is currently facing multiple criminal cases [18, 17]. The paper will not explore such topics in-depth as they are outside of the scope and focus of the study; however, these may be touched upon briefly if it is a popular discussion point among users in the data collected.

1.5 Significance of the Study

This paper aims to contribute to the field of social computing by analyzing the behavior of users in online spaces during election periods. By way of sentiment analysis and other NLP techniques, the research aims to gather statisti-

cally large amounts of social media data that represent the general public, and after which makes use of models that process such data and draw insights from the sentiments behind social media posts concerned with presidential elections.

The analytics and findings of this study will benefit the general public's knowledge of how social media runs in both Philippine and American contexts, especially during the election seasons. These findings will also provide them with more context between the spheres of social media in terms of various political ideologies that the said candidates have. The researchers hope to impart realizations on how social media, despite shaping public opinions, might not be the definitive factor behind electoral wins.

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of related literature of the research examines existing studies grouped according to the following discussion points: the importance of sentimental analysis, especially in the context of presidential elections; the definition of the BERT model and how it is effective in classifying sentiments of social media posts; how social media has become a critical tool for political engagement and in building the general public's sentiment; and backgrounds on the Philippine and US presidential elections that are to be analyzed.

The sentiment analysis subsection discusses its definition and how it is essential in analyzing social media engagement. Next, tools used for analyses will be discussed, especially the transformation model `Bidirectional Encoder Representations from Transformers (BERT)`— its architecture, a variation of RoBERTa, how effective BERT is for sentiment analysis using various studies as evidence, and the capabilities of `XLM-RoBERTa`. Lastly, the Elections and Social Media subsection discusses how social media shapes the general public, especially in the context of the Philippines and the United States.

2.1 Sentiment Analysis for Social Media and Elections

According to Liu [2012], the study of people's views, sentiments, assessments, appraisals, attitudes, and emotions about goods, services, organizations, people, problems, events, subjects, and their characteristics is commonly referred to as sentiment analysis or opinion mining [23]. With the explosive growth of social media, it has become a hotspot of opinions, shaping our decisions, especially in an important political event like elections. In the field of social computing, election seasons are one of the widely researched topics, especially on how the interaction in social media affects society in terms of making decisions on who to vote for. With the recent rise in popularity of many large language models (LLMs) like ChatGPT, LLMs have also been considered to perform sentiment analysis tasks. LLMs have been measured and evaluated to have satisfactory performance in simpler tasks, lag behind in more complex tasks requiring structured sentiment information, and have a potential when annotation resources are limited [24].

There are examples of studies using sentiment analysis to analyze social media activity. In a study by Macrohon, et al. [2022] and Demillo, et al. [2023], they used the `Naïve Bayes classifier`, a probabilistic learning method, to determine the probability of a tweet belonging to the best class—applicable in de-

termining the polarity of a post [26, **?**]. Then, previous studies showed the usage of bidirectional encoder representation from transformers (BERT) models, modified to handle emojis and Tagalog language tweets. Aquino, et al [2025] introduced the emotion-infused `BERT-GCN model` for sentiment analysis, which includes emoji semantics into the models, treating them as sentiment representation [4]; meanwhile, Cruz, et al. [2022] used the `RoBERTa-tagalog-cased model` to get the vectorized version of Tagalog embeddings, essential to map echo chambers on Twitter via `K-Means modeling` [12]. Lastly, the `Support Vector Machines (SVM) Classifier model` was used by Demillo, et al. [2023] to handle binary classification of data, classifying them as either a negative or positive sentiment [13].

For reasons discussed more in-depth in the next section, BERT was chosen for the study's methodology given its capabilities of performing nuanced analyses and classification of social media posts.

2.1.1 BERT and RoBERTa

Recent developments in devising models for NLP tasks have ensured that models are updated to be more context-aware, being able to provide a more holistic and nuanced analysis of certain texts. One such model is BERT, short for Bidirectional Encoder Representations from Transformers (referred to henceforth as BERT). Developed by the Google AI Language Laboratory, the main advantage

provided by BERT is its ability to analyse text in a bidirectional manner, as opposed to more traditional machine learning models, such as GPT, which only analyse text left-to-right or vice versa. Bidirectional analyses of text ensures that BERT is able to capture not only the sentiments of text, but do so in such a manner that the model is able to detect certain nuances, such as sarcasm or irony. BERT's architecture is built on transformers, an architecture of neural networks that uses a combination of recurrent and convolutional networks.

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BERT is primarily pre-trained in two phases: first, using a large dataset of unlabeled data, then second; a smaller set of labeled data, usually for fine-tuning the BERT model according to some NLP task. One such NLP task is Sentiment Analysis [20]. In pretraining, BERT operates on two main objectives. The first is the Masked Language Model (MLM henceforth). A random sample of tokens in the input sequence is selected and replaced with a special mask token [MASK]. The objective is then for the BERT model to be able to predict what these masked tokens are. Next is Next Sentence Prediction (NSP), a binary classification task. The goal is for the model to be able to predict whether two text segments follow each other. Both positive examples (consecutive sentences from the training set) and negative examples (pairs of segments from different documents) are provided

and are sampled with equal probability.

In 2019, the Facebook AI research team found that BERT was "significantly undertrained", and thus proposed RoBERTa, short for "[A] Robustly Optimized BERT Pretraining Approach". The team sought to improve the training process of the BERT model by (1) training the model over a longer period of time, and with bigger batches of data, (2) removing the NSP objective in pretraining, and (3) dynamically applying the masking pattern applied to the training data. The results of this optimized pretraining process do show, indeed, that RoBERTa is able to either match or exceed the performance of BERT in NLP tasks, the former scoring higher than the latter in multiple NLP model evaluation tests such as GLUE, SQuAD, and RACE [25].

As BERT and RoBERTa have seen usage in analysing large datasets of text, it is able to aid in research on social media. Social media is considered a rapidly evolving form of text widely different from more traditional text formats such as novels mainly due to the widespread usage of informal language, abbreviations, and emojis, among other elements, which can be challenging to understand without the proper context.

For one, Kumar and Sadanandam [2023] were able to use BERT and RoBERTa to classify a large dataset of some 8,225 tweets related to the Coronavirus into three general sentiments: positive, neutral, and negative. Both BERT

and RoBERTa were able to perform sentiment analysis across the entire dataset, achieving high accuracies (at least 88%), precision (at least 0.88), recall (at least 0.74 but can go as high as 0.91), and F1-score (at least 0.78 but can go as high as 0.90) [31]. Prasanthi, et al. [2023] were also able to accomplish a similar feat using both BERT and RoBERTa, performing sentiment analysis on large social media datasets with extremely high accuracies, these accuracies only improving with each succeeding epoch. BERT was able to achieve a base accuracy of 95.10% on the first epoch, which only increased to 99.16% on the tenth epoch. Similarly, RoBERTa was able to achieve a base accuracy of 99.53%, with a final accuracy of 99.70% on the tenth epoch [32].

As mentioned earlier, BERT and RoBERTa are able to capture nuances such as sarcasm and irony in texts. Detecting sarcasm, in particular, has proven to be a highly challenging NLP task as a sarcastic statement implies a negative sentiment whilst seemingly conveying a positive one surface-level. Nevertheless, Dong, et al. [2020] were able to train RoBERTa on a dataset of posts from Reddit and X (formerly Twitter) to give it the ability to detect sarcasm in a given text, with an F1 score of 80.2 [14].

These studies illustrate the importance of RoBERTa and BERT in the context of sentiment analysis on highly informal and nuance-laden texts such as social media posts.

2.1.2 XLM-RoBERTa

Since RoBERTa's release, there have been updated revisions of the model that further increase RoBERTa's performance on certain NLP tasks. In 2020, the Facebook AI team released another version of RoBERTa that is also able to handle texts in languages other than English. `XLM-RoBERTa`, short for Cross-lingual Model RoBERTa (referred to as XLM-R henceforth), is trained with some 2 terabytes of data using texts on 100 languages, and trained using the MLM objective.

The team then evaluated the model, alongside other versions of BERT, in different tests. Firstly, the `XLNI`, short for the Cross-lingual Natural Language Interface, is a dataset containing training and testing datasets in 15 languages. The goal of the dataset is to evaluate a model's cross-lingual transfer from English to another language. XLM-R was able to outperform mBERT (multilingual BERT) in this test, with an advantage of around 10% in terms of per-test accuracy.

Next is the `Named Entity Recognition test`, which evaluates not only cross-lingual transfer, but also the model's performance per-language as well as multilingual learning ability. Also included are the Cross-lingual Question Answering test and finally the `GLUE benchmark`. Again, XLM-R outperforms mBERT on all tests, and was also shown to be able to effectively model low-resource lan-

guages such as Swahili and Urdu [11].

Other studies have been published since the release of XLM-R showing its prowess in processing multilingual texts, and outperforming other models in the same tasks. Azadi et al. [2025], for example, trained both XLM-R and GPT 3.5 to classify a bilingual dataset of tweets (composed of English and Spanish tweets) through two tasks. The first task was to determine whether or not the tweet has sexist content, and the second was to determine what type of textual content the tweet has with regards to sexism (if the tweet contained purposively sexist content, was reporting a sexist situation, or was condemning certain sexist behaviors). XLM-R was shown to outperform GPT 3.5 on both tasks: in Task 1, XLM-R and GPT scored an over F1 score of 0.78 and 0.71, respectively; while in Task 2, XLM-R scored 0.48 as opposed to GPT's 0.43 [5].

2.2 Elections Background

It is imperative to recognize the interconnectedness of the 2016 and 2022 Philippine presidential elections and the 2020 and 2024 US presidential elections. Other than the recurring leading candidates in some of the nations' electoral campaigns, social media has been recognized as a strong tool to spread awareness about a candidate's identity. The 2016 Philippine presidential election is widely considered the first "social media election" in the Philippines [35].

Similarly, politics on the internet is one of the main factors that led to Donald Trump's swift rise in 2016 and his eventual re-election in 2024 [30].

2.2.1 Philippine Elections

In his study on the 2016 Philippine presidential elections, after analyzing pre-election surveys, the candidates' campaign strategies and their advocacies, and their supporters' age demographic and news tracking, Holmes [2016] observed that the elections in the Philippines are political clan-dominated, personality-oriented, and media driven [16]. Almazan et al. [2023] sums this point aptly, "Philippine presidential elections have traditionally been characterized by the dominance of political popularity, populism, and financial interests, often marred by incidence of violence and electoral fraud. [2]"

Rodrigo Duterte's victory in the election was believable to the public and was attributed to the clarity of his campaign slogan, his significant support from a geographic area, and how he criticized and questioned the character and competence of his fellow candidates. However, one of the most significant observations in the study is the importance of the media, which is updated in real-time and where voter preference was shaped and reformed by Duterte's critiques and 'bashing' [16].

Following Duterte's term in office, Ferdinand 'Bongbong' Marcos Jr.'s elec-

toral win has caused much uproar among the nation's scholars. The general resurgence of the Marcos Clan in politics can be attributed to 3 factors: (1) the people's nostalgia of the Marcos era, (2) Duterte's political influence, and (3) the Marcos' years-long digital disinformation campaign on social media [29].
Duterte's consequent influence on Marcos' resurgence cannot be dismissed, as signs have pointed out that Duterte's indirect endorsement led to his win [15].

"The recent election has been the most social media-active and engaging campaign in the country's democratic history." said Ampon, et al. [2023] in a paper analyzing the political message strategies of Marcos and Robredo. In the 2022 Philippine presidential race, both leading candidates (Marcos Jr. and Robredo) have taken great leads on social platforms like Facebook and X, respectively, to spread their identities and ideologies [3].

2.2.2 US Elections

Posada [2025] observed that Trump's online use was demagogic and harmful to political practices in the US because he revolutionized social media as a new space to center politics and normalized demagogic behavior to spread information, release reckless statements, encourage national division, and attack government institutions.

At the cusp of the COVID-19 pandemic, the 2020 US presidential election

had taken a major hit– particularly for one of its leading candidates, Donald Trump, whose vote share is largely affected by COVID-19-related cases [6]. It is likely that Trump was viewed negatively for how he handled the pandemic as the most affected counties and states are ones without stay-at-home orders, in swing states, or states that Trump won over in 2016. This mismanagement is what likely led to changes in voter preferences and Joe Biden's eventual electoral win.

The 2024 US presidential election was predicted to be one of the most competitive in modern history with a tight competition between candidates Donald Trump and Kamala Harris, the new face of the Democratic Party [34]. Although Harris and Trump's campaigns share some details, they differ vastly in their long-term goals [30]. In the end, Trump had managed to win the electoral race with a large voter turnout from the Hispanic/Latino and young voters population [30].

2.3 Social Media Use and the Elections

2.3.1 Candidate Activity

The 2016 and 2022 Philippine presidential elections are undoubtedly linked as they involve something other than the rise of the Marcos-Duterte alliance: the prominence of social media as a means to bolster their presence in people's lives

and boost their popularity.

Despite having the most engagement, Duterte's online presence during his presidential campaign is nothing short of lackluster and underwhelming [35]. Sinpeng et al. [2020] described his online campaign as bland and impersonal, obviously written for him by his social media team as it lacked Duterte's tough-talking style and were mostly in third-person [35].

On the other hand, Marcos Jr's campaign has been well-established and maintained in the years leading up to his campaign [27]. His pitch throughout the campaign calls for national unity, featuring the glorification of his father's legacy. In Rappler's three-part study on "networked propaganda" back in 2019, there was a rise in many pro-Marcos pages and channels on different social media platforms, notably on TikTok and some documentaries on YouTube. There was less activity from Marcos Jr. himself, however, those channels were particularly full of pro-Marcos content [27].

On the other hand, Trump did not hesitate to engage in social practices that belittled, offended, and borderline harassed his opponents [30]. "Not unlike an advertiser offering the public a new product or political propaganda of decades past, Trump erased the line between myth and truth through an informal style built around a radicalist discourse, rooted in populism, that convinced supporters to trust his words over any other source." Bissonette [2020] expressed [8]. Harris'

social media campaign failed to replicate Trump's success because he was willing to engage in demagogic behavior in public and online, making him appear more genuine [30].

2.3.2 Public Opinion

Duterte's successful campaign can be attributed to his aggressive supporters– most of whom are vocal online and active offline. As observed by Sinpeng, et al. [2020], despite Duterte's unprofessional online presence, his supporters are committed and constantly rallied to his defense against the criticism of other candidates [35]. There are also prospects of the heavy involvement of informal actors like paid trolls and influencers as having major roles in mobilizing (and agitating) digital communities, which helped spread his popularity [35].

Over the years, Marcos Jr. has amassed a large number of supporters on TikTok based on the top 4 trending hashtags related to him: `#bongbongmarcos` (3.4 billion views), `#bbmsara2022` (2.3 billion views), `#uniteam` (2.5 billion views) and `#bbm2022` (2 billion views) [27].

2.3.3 Voter Preference

Over the years, social media has become the first reference of the voters when it comes to perceiving political content and eyeing political information,

political groups, and political parties [10]. Social media was extensively used by politicians to report their activities, both political and personal, and advertise their brand to their supporters [13], These researches are backed up by a study that found the most influential sources of information for voters' preference in Philippine elections to be social media [2]. Findings from Qorri's [2018] study also suggest that "social identity, family voting, gender differences, ideology, and emotions are critical in guiding (voting) behavior. [33]" Specifically, Almazan et al. [2023] found that specific candidate attributes resonate with the demographic as their most preferred qualities in presidential candidates: "A male lawyer with prior experience in elected office, aligning with liberal ideologies, prioritizing education, and possessing a doctoral degree. [2]"

CHAPTER III

METHODOLOGY

The methodology will follow the Figure 3.1.

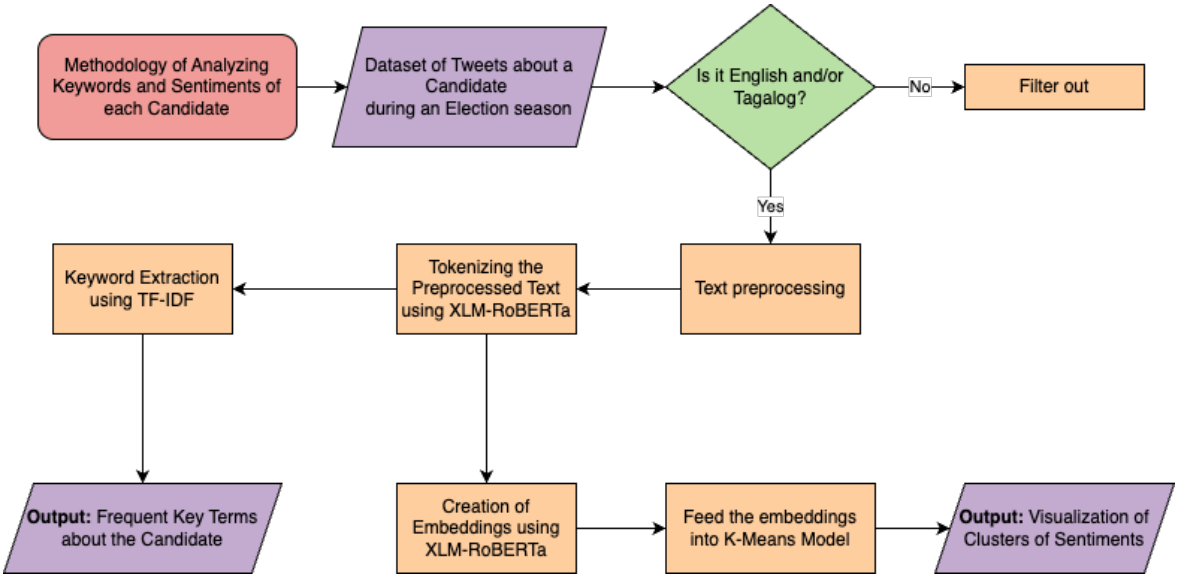

Figure 3.1: Methodology Flowchart

3.1 Data Collection

There are publicly available datasets for the 2024 US Presidential elections; however, for the 2022 Philippine Presidential Elections, the researchers will have to use a third-party Application Program Interface (API) due to the discontinued official free Academic API from X (former Twitter). In collecting tweets, keywords and dates will be utilized to perform an advanced search to get

the tweets needed for the analysis.

Presidential Election Year	**Intention to Run Announcement**	**Dates within the Dataset (Inclusive)**	**Key Terms**
2022	Marcos and Duterte: October 5, 2021 Robredo and Pangilinan: October 7, 2021	May 9, 2022	Marcos, Duterte, Robredo, Kiko, Pangilinan, BBM, Leni, DU30, Uniteam, Bongbong

Table 3.1: Table for Philippine Dataset Ranges

Presidential Election Year	**Intention to Run Announcement**	**Dates within the Dataset (Inclusive)**	**Key Terms**
2024	Trump and Vance: November 15, 2022 Harris and Walz: July 21, 2024	November 8, 2024	Harris, Walz, Trump, Vance, Kamala, JD Vance

Table 3.2: Table for United States Dataset Ranges

The end dates are until election day because of the high chances of a spike of sentiments especially as election days come closer.

Each collected tweet is in JSON format. For it to be utilized for natural language processing, it will be saved as a `.csv` file, separated, with each row marked by which country it belongs to, because it will be utilized for text classification.

3.2 Data Preprocessing

Before a group of datasets is fed into a tokenizer, they will undergo text processing. Stop words such as *"the," "a," "is"*, etc., will not be removed as they might be considered for the full context of a sentence when performing byte-tokenization. The following steps to preprocess the text will be as follows:

- Omitting a tweet from the dataset if it is not in English, Tagalog, or a mix of them. The languages of the tweets will be detected by the Python library `langdetect`.
- Removing punctuation marks that have no significance for sentiment analysis.
- Replacing emojis with special tags.
- Removing unnecessary emojis or replacing emojis with special tags describing them if it is necessary for sentiment analysis.
- Lowercasing the text.
- Handling links and email addresses by replacing them with a placeholder.
- Removing whitespaces and replacing multiple spaces with a single space.
- Adding paddings to equalize the length of sentences.

The preprocessed dataset will be placed in a new `.csv` file. It is expected that the dataset, after they are preprocessed, will be 20,000 tweets per election.

3.3 Text Classification and Visualization

3.3.1 XLM-RoBERTa

After the preprocessing, the dataset will be fed into the following models: the `XLM-RoBERTa` model for contextualized embedding and the TF-IDF model for determining frequent keywords. XLM-RoBERTa's language-agnostic approach makes it easier to implement as there is no need to identify if certain texts are in English or Tagalog.

Once the preprocessed dataset is fed into the model, the resulting tokens will be used to determine frequent keywords via TF-IDF and semantic similarities on the embedding model.

3.3.2 GMM Model

Once the embeddings are generated, they will be compared for semantic similarity via `Gausian Mixture Model (GMM)`, an unsupervised probabilistic clustering algorithm. GMM clustering, in contrast with K-Means clustering, are modelled as Gausian distributions, providing them flexbilitiy in handling overlapping clusters and variance differences, especially XLM-RoBERTa produces

contextualized embeddings in high dimensions. In the context of nuanced tweets or tweets with mixed emotions, GMM's soft clustering handles it better because it gives probability distributions, which is valuable for interpreting such tweets. The embeddings will be fed into the GMM model and it will provide soft assignments to each embedding, allowing them to belong to multiple clusters with different probabilities. The manually marked sentiments, which will be colored in the visualization, will serve as an evaluation to see if the tweets of same sentiments belong to the same clusters.

The clusters will be quantitatively evaluated by `Adjusted Rand Index (ARI)`, which examines the similarity between two clustering assignments. It will be used to determine if the agreement between the sentiment clusters and manually labelled sentiments.

3.3.3 TF-IDF

Meanwhile, the tokenized texts will also go to the `TF-IDF model` to determine the frequency of words. The frequency of the words is sorted by how frequently they are used in a certain post or comment. The top keywords per candidate will be used to compare and contrast with other candidates and the social media spheres of the two countries.

3.3.4 Visualization

The interactive visualizations of the analysis consist of the following: a word cloud of the most frequent words and cluster visualization of semantic meanings. Using the time and date indicated in the dataset, they will be used to visualize the sentiments of the tweets during early election, mid-election, days before the election, and the election day itself. It will also highlight the surveys from public opinion polls to match if these strong sentiments has a correlation with the public polls and the election turnout on the day of election.

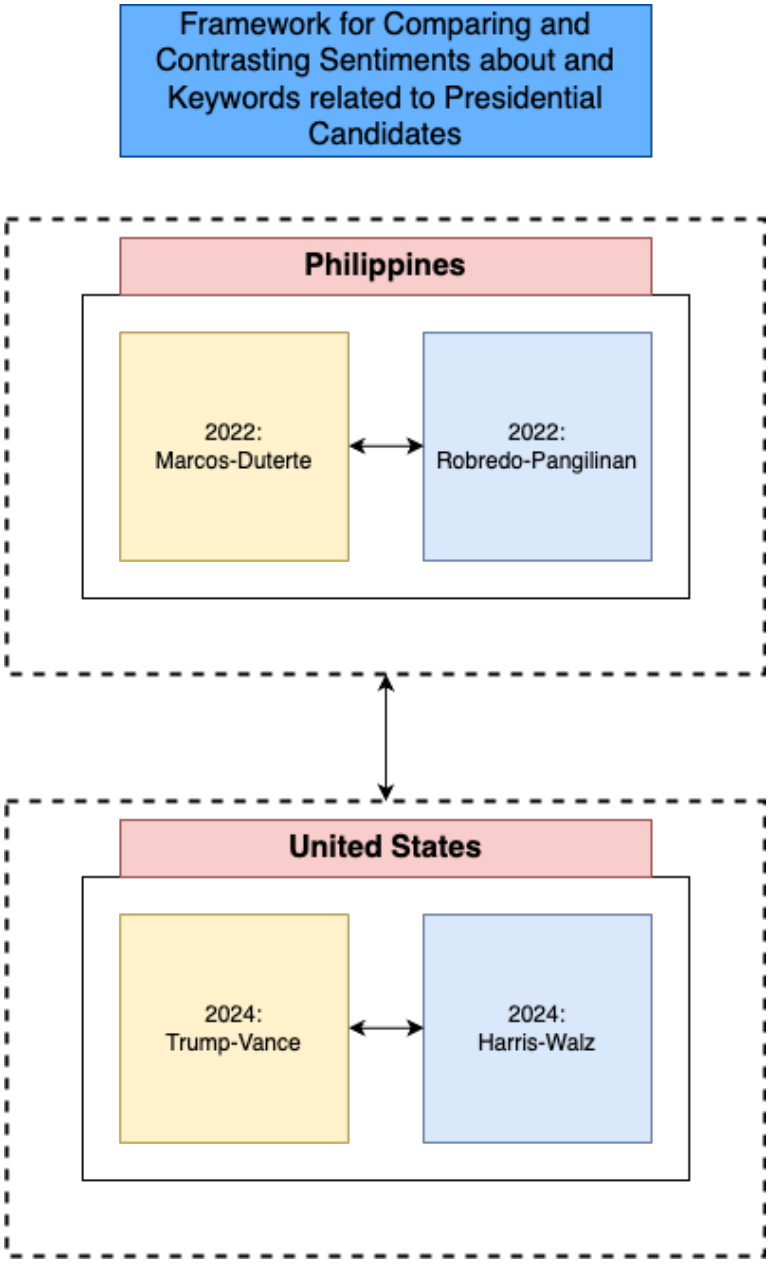

Figure 3.2: Framework for Comparing and Contrasting Sentiments

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