

Original Article

Sentiment Analysis Model to Predict People's Opinion of the Trimester System in Saudi Arabia

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Abstract - The trimester system is a new academic system in the education sector in Saudi Arabia. At the beginning of 2021, the Ministry of Education announced the introduction of the trimester system in general education, aiming to overcome the gap between the actual number of study hours in Saudi Arabia and those in international educational systems. This paper, using the sentiment analysis of Twitter data, investigated people's opinions about the trimester system. We extracted and conducted a multi-class classification model using several machine learning classifiers to classify each tweet in terms of its sentiment polarity appropriately. Results showed that both Linear Regression and Random Forest classifiers achieved better performance with multi-class models than other classifiers. The analysis results showed a neutral emotional state of most Saudi users regarding the trimester system. This indicates a need to explain the policies and changes regarding this system to people, so they understand this system better. The results of this research could help decision makers to understand the emotional aspects of the trimester system in the Saudi community.

Keywords - Sentiment analysis, Opinion mining, Machine learning, and Governmental services.

1. Introduction

With the increasing demand among Saudi Arabian citizens for better governmental services, it is important to explore their needs. The Ministry of Education in Saudi Arabia decided to minimize the gap between the actual number of study hours in Saudi Arabia and those in some international educational systems by proposing for the first time the concept of a trimester system in the education sector in Saudi Arabia. Unlike the two-part semester system, the trimester system is an educational calendar that divides the study year into three parts, each of which is 3 months long. In 2021, the Ministry of Education in Saudi Arabia started to apply this system in general education, and their plan is to apply it in universities' academic year by 2023. As with the launch of any new system, with the launch of this system too, it is important to understand the general emotional opinion of Saudi people about it.

With the rapid growth in the amount of user-generated content in different social media services, it has become easier for people to express their thoughts on these services. Statista reported that Saudi Arabia has the fifth largest number of Twitter users in the world [1,15]. Therefore, many researchers treat Twitter as a data source to predict general opinions about any service, as, for example, did the authors in [2–5]. Sentiment analysis or opinion mining[6] is heavily used to understand and explore users' general opinions about different

topics discussed in any society. Understanding people's opinions could critically impact improving the provided services, exploring users' needs, and measuring general acceptance.

Recently, Twitter data have gained a lot of attention from researchers as a source of information. It is mentioned in [30] that the number of tweets per day has increased to over five hundred million. Twitter users use Twitter daily for many reasons, such as socialising with others, navigating for information, or having fun simply. Moreover, a wide variety of topics are discussed daily on Twitter, ranging from simple sleeping notes to more complicated topics, such as politics and technology. Many companies and organizations invest in analyzing tweets to gain a clear vision of customers' needs and evaluate their products accordingly. A company or organization may consider reviews regarding any aspect of a product as an insightful and valuable piece of information to improve that product [2]. However, there is little information on Twitter on how users interact with governmental services provided by different Saudi Arabian ministries. To the best of our knowledge, there is no previous study investigating the general opinion about the trimester system in Saudi Arabia by analyzing Arabic tweets using sentiment analysis techniques.

Researchers, professionals, stakeholders, companies, and others benefit from the sentiment analysis technique by



analyzing and extracting information. Sentiment analysis technology helps them to know the extent of customer satisfaction with products and what steps to take in the future to improve the products since people now tend to express their opinions and ideas more openly than before. Hence, sentiment analysis has shown promising results in discovering users' emotional states in different situations. In this research, we found that it is potentially important to investigate people's opinions about the trimester system, especially in its early stages. This research addresses the problem of investigating users' opinions about the applicability of the trimester system. To the best of our knowledge, this study is the first research that dynamically reflects people's opinions of this topic through their interactions with the tweets related to the trimester system on Twitter.

This research's results will help decision-makers fill any gap in people's understanding of the new system. We developed a multi-class classification model based on several machine learning classifiers using a dataset collected from Twitter. The model was evaluated using performance measures, and qualitative analysis results were reported to reflect people's opinions about the trimester system. This paper is structured as follows: Section 2 discusses related works focused on sentiment analysis using a machine learning approach. Section 3 demonstrates the proposed methodology, including all phases. Section 4 shows the main results of the analysis. A conclusion, along with direction for future work, is provided in Section 5.

2. Related work

Social media analytics has emerged as a fundamental aspect of research because it represents the actual voice of customers and Internet users and is considered quality data by many researchers [7]. The increasing use of social media platforms has substantially influenced different aspects of business and everyday life. Given the popularity of these types of services among users, benefiting from the amount of massive user-generated content becomes inevitable for many researchers.

The main principle of social media analytics is to gain meaningful knowledge from this content, considering its value as a source of unstructured external information [8]. There are several social media analysis techniques to transform the collected data into meaningful knowledge, such as sentiment analysis, topic modeling, and stance detection. Social media analytics approaches have been found to be applicable in many domains and sectors, such as tourism and hospitality [9, 10]. Social media analytics based on sentiment analysis has been widely used for extracting and analyzing public opinion on various topics, events, and services [29]. A disaster management study conducted by Beigi et al. to define different stages of a particular disaster investigated the general public opinion from comments posted on Twitter [31]. To predict climate change, Dahal et al. [12] carried out a sentiment

analysis of tweets, and to identify the most commonly discussed topics, they performed a topic modeling.

One of the earliest domains that benefitted from the use of sentiment analysis was business and marketing. Since there is no in-person communication in online shopping, customer reviews are used as a crucial tool to identify customer experience with different products [13]. One of the challenges for a business to understand its market is to assess its service level and quality from a customer point of view. To perform this evaluation, sentiment analysis techniques are used on online user reviews to extract opinions. Nowadays, everyone can create content and share their opinions and information easily. Earlier, to obtain data, most companies used traditional methods, such as questionnaires and sampling. This approach was time-consuming and costly. Therefore, these days, many companies analyze the quality of samples and the level of service using data generated by customers and users on online feedback sites. This method is established through sentiment analysis that determines the quality of e-commerce products.

Accordingly, Sari et al. (2021) [14] used a set of data collected from an online review site. The results showed that the perception of customers and consumers about the quality of services was balanced; that is, customers found the services to be good despite the presence of some weaknesses. The data analysis approach to measure the quality of e-commerce has been considered an effective and efficient approach. To obtain representative results, it is necessary to analyze the data more accurately through different platforms, such as Twitter and Facebook [14]. Hu et al. [34] proposed a novel approach that determined the impact of ratings and customer reviews on predicting the sales of books on Amazon. They found no significant relationship between ratings and sales, but customer reviews have a significant impact on sales. They also found that the first few reviews on the list have more impact on book sales than other reviews [34].

In the case of governmental services, Alsulami and Mehmood [2] used sentiment analysis to predict people's acceptance of a new system applied to Saudi universities in 2018. Their study identified general concerns about the new system. Another educational topic that was investigated through the use of sentiment analysis is the online learning experience during the COVID-19 pandemic. Aljabri et al. [16] conducted a binary sentiment analysis classification model using tweets in the region of Saudi Arabia to explore the users' opinions about the distance learning experience in Saudi Arabia. Their results showed positive opinions about the online learning experience for general education stages and negative ones for university stages [16]. Althagafi et al. [17] proposed a lexicon-based sentiment analysis model regarding the online experience during the COVID-19 pandemic in Saudi Arabia. They found that Saudi users maintain neutral responses to online experiences [17].

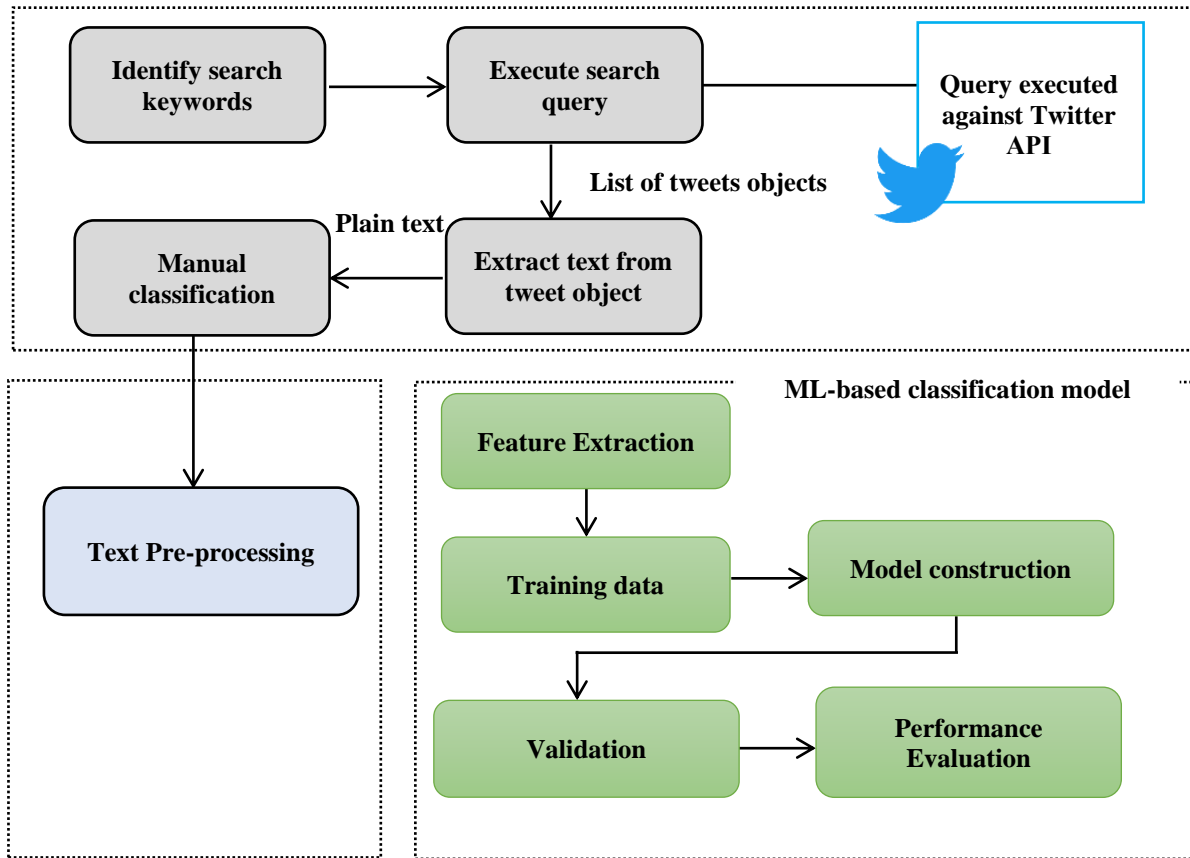


Fig. 1 Proposed methodology

3. Methodology

The methodology this research followed involved three stages, divided into several tasks, as illustrated in Figure 1.

3.1. Data Collection Phase

Twitter was used as the source of our dataset because the majority of its users in daily basics are from Saudi Arabia, according to [19] and [32]. There are several Twitter APIs and libraries available to allow developers to crawl tweets easily from Twitter.

Tweepy is a python library widely used by developers to collect tweets [20]. A developer account must be created to access all provided services. However, Tweepy has a limitation regarding the maximum number and the time frame of the extracted tweets. The standard search API in Tweepy is restricted to retrieving only 3200 tweets as a maximum for the preceding 7 days. A lot of time is needed to overcome these limitations.

As an alternative, in this research, as an advanced Twitter scraping tool, the Twint tool was used, which is written in python and does not have the limitations of Tweepy. It allows for several configurations while scraping tweets from Twitter, such as specifying a time frame, extracting an unlimited

number of tweets, and specifying the region of the posted tweets[21].

The dataset in this research was collected using the same search queries in different time frames. The collected dataset was used to train and test the created machine learning model using a variety of machine learning classifiers.

To demonstrate people's opinions about the trimester system of education in Saudi Arabia, some keywords and hashtags were used as search keywords in the search queries run by Twint. Table 1 provides examples of these keywords and hashtags. Note that all keywords and hashtags were in the Arabic language since the focus of this research is on the opinion of Saudi users regarding the trimester system. A total of 8729 tweets were extracted as our dataset, collected between August 2021 and August 2022.

3.2. Preprocessing Phase

While creating any classification model, the preprocessing input text is an essential step due to its potential role in ensuring a reliable classification process. In this research, the preprocessing steps in [11, 22] were followed and applied to the collected dataset. Some steps were added to fulfill the requirements of this research. The preprocessing phase includes the following actions:

Table 1. Examples of some used keywords and hashtags

Keywords/hashtags (in Arabic)	Keywords/hashtags (in English)
#الفصول_الثلاثة #الانترام_الثلاثة	#Three_semester
#تطالب_بالغاء_الفصل_ا لثالث	#Cancelation_of_the_three_semester
#الفصل_الثالث #الترم_الثالث	#Third_semester
الفصول_الثلاثة - الانترام الثلاثة	The three-semester
الفصل_الثالث	The third semester
نظام_الفصول_الثلاثة	Three-semester system
التقويم_الدراسي_الجديد	New school calendar

Table 2. Examples of some preprocessing actions

Tweet Example	Performed actions
ليله27 يارب يلتغي الترم الثالث ياخي ياقيوم	Removing all non-Arabic characters
لمن تلغي الترم الثالث ياااa	

- Removing all non-Arabic characters.
- Removing all diacritics.
- Removing all Arabic punctuations.
- Removing repeating characters.
- Removing mentions, URLs, and stop words.
- Applying Arabic normalization.
- Removing Tashkeel.
- Removing emoticons and hashtags.

Table 2 shows examples of preprocessing actions that were performed on our dataset.

3.3. Classification Phase

Classification is the process of classifying each data input to a predefined label or class based on certain features. Supervised machine learning models have been widely used to facilitate classification based on pre-trained data on selected features.

In this research, the classification phase consisted of two main stages. First, a manual classification was performed,

before preprocessing, to remove any irrelevant tweets. Second, a sentiment-analysis-based model was trained and conducted using a supervised learning approach by using several ML algorithms to classify an extracted tweet into one of three classes: positive, negative, or neutral. The decision to use a three-class classification model was made because of the nature of the research topic.

The dataset was divided into 80% training data and 20% testing data. This research applied a randomized under-sampling technique [24,33] to handle the large number of neutral tweets detected during the training phase. We ended up with 2400 tweets for each class.

Because training data is a time-consuming process, it was decided to use MAZAJAK API¹ as an automatic annotator. MAZAJAK is an online Arabic sentiment analyzer based on a deep learning model [25,28]. It provides a three-way sentiment analysis classification, which is suitable for selecting classes in this research. The second annotator in the training phase was an Arabic human annotator. To measure the agreement between the two annotators, kappa was calculated (kappa = 0.52), which is considered moderate according to [26]. If there is a disagreement between the two annotators, a third annotator judges which label is more suitable for that tweet. To guide the human annotator in the annotation phase, the following definition was given to them:

- Positive tweets: These are tweets that contain explicit positive keywords or phrases.
- Negative tweets: They are tweets that express negative feelings using explicit negative keywords or phrases.
- Neutral tweets: They are tweets that represent news/facts/policies/questions about the new trimester system in the education sector without mentioning any positive or negative keywords or phrases.

The annotation process is illustrated in Figure 2.

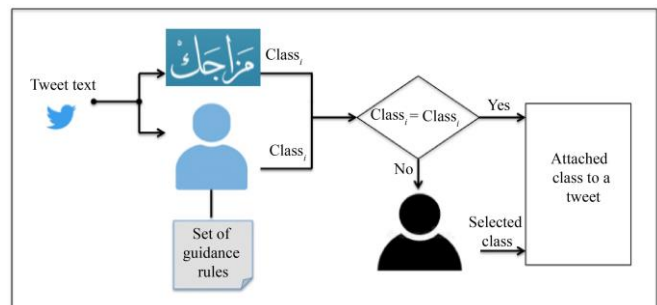


Fig. 2 Data annotation process

4. Results and Discussion

The results were reported in two forms. First, all the performance results of the conducted model using the ML algorithms were obtained using performance measurements. Second, the results of analyzing the sentiments of the collected tweets were reported by demonstrating the most frequent words in each class, the general sentiment polarity of the extracted tweets, and the daily distribution of tweets.

In terms of performance evaluation, Naïve Bayes, Logistic regression, SVM, and Random Forest classifiers used a machine learning model. Table 3 presents the evaluation results of the four machine learning classifiers used. It shows that the Logistic regression classifier outperformed other ML classifiers in terms of accuracy [23], precision, and F-score. A comparison of the four conducted classifiers indicates that both Logistic regression and Random Forest multi-class classification methods achieved the highest scores in all performance measures compared with Naïve Bayes and Support Vector Machine because they work well with high-dimensional data, such as text data [17].

The goal of this research is to provide a better understanding of people's opinions of the trimester system applied in the education sector in Saudi Arabia. This research analysed the extracted tweets' overall sentiment through a sentiment analysis model. These analyses were performed before applying the under-sampling that was mentioned earlier during the training of the data.

Results of the analysis showed that the most sentiment polarity detected in the dataset was neutral, which indicates that most Saudi users focus on understanding the new system's policies and principles and asking questions about it. Most neutral tweets were questions or news about the system's launch in some Saudi universities. Fig. 3 shows the most frequent words in neutral tweets.

The second sentiment polarity detected in our dataset was negative. Negative tweets expressed an attitude of refusal toward the trimester system. We observed that some negative tweets elaborated on some disadvantages of the trimester system and complained about the decision to move to this system completely. A few tweets in the dataset (15.2%) were positive and mostly expressed good wishes for the new system, as shown in the second-most-used word in the positive tweets in Fig. 4.

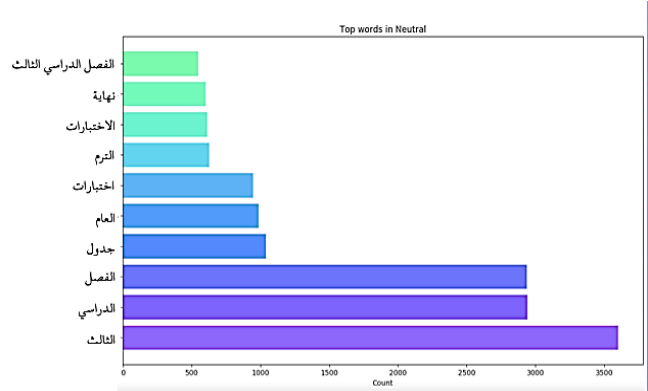


Fig. 3 Most frequent words in neutral tweets

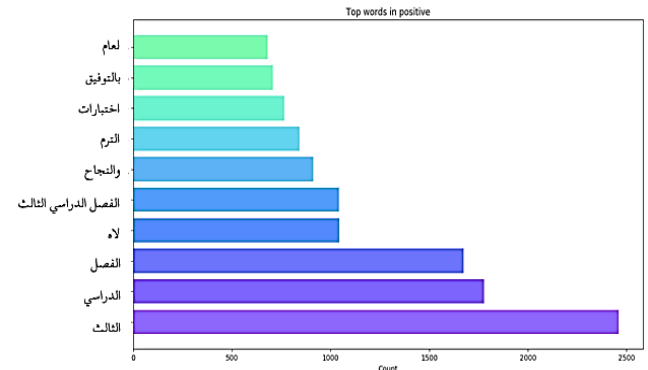


Fig. 4 Most frequent words in positive tweets

While analyzing the dataset, the monthly distribution of tweets was explored on the trimester system. The majority of tweets (66.12%) were published in June, as shown in Fig. 5.

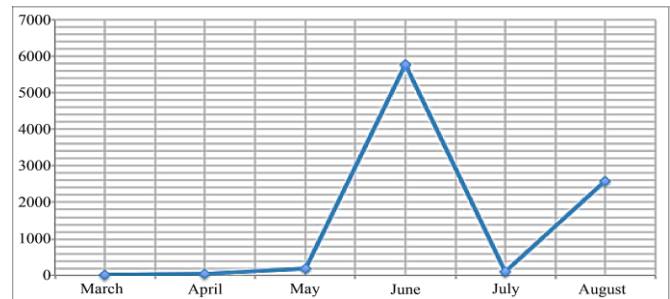


Fig. 5 Monthly distribution of Tweets in our dataset

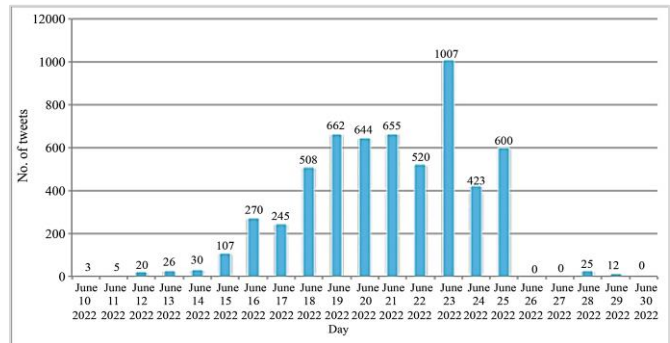


Fig. 6 Daily distribution of tweets during June 2022

Table 3. Evaluation results of the four machine learning algorithms

Classifier	Accuracy	Precision	F-score
Naïve Bayes	0.829	0.828	0.826
Logistic Regression	0.901	0.899	0.899
Support Vector Machine	0.584	0.624	0.584
Random Forest	0.892	0.890	0.890

Conversely, Fig. 6 shows the daily distribution of tweets in June. June was the last month in the school year before final exams, and that could have raised people's concerns about the new system and led them to discuss the topic at the time extensively.

5. Conclusion

Evaluating government services and new systems is essential for decision-makers to adapt the systems and make necessary improvements. Sentiment analysis is widely used to explore people's general opinions and reflect on their thoughts and expectations about new services. In this study, we investigated people's emotions regarding the implementation of the trimester system in the education sector in Saudi Arabia. This topic has garnered substantial popular interest in society since its announcement. We conducted a sentiment analysis model using different classifiers and applied it to a dataset we collected from Twitter. The model achieved 90% accuracy when it used the Logistic Regression classifier, which

indicates the effectiveness of this classifier with multi-class classification models. Our results showed that the most frequent sentiment detected in our collected dataset was neutral. Neutral tweets were mainly on news and questions about the trimester system, which indicates the need to establish an effective communication network to clarify changes. In the future, we plan to study this system after applying it in Saudi universities and incorporate different analyses, such as quantitative analysis, to gain insightful results in this domain.

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