



Sentiment Analysis of Climate Action Issues on Twitter Using Orange Data Mining

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ABSTRACT

The 2030 Sustainable Development Goals (SDGs) related to climate change are multidimensional issues that impact all aspects of society, including public health and human rights. To understand how a group views the issue of climate action, it is necessary to identify the opinions they express to develop appropriate climate action strategies with direct community involvement. This study aims to capture public discussions, especially from young people, regarding climate action on Twitter. The data used in this study were collected from Twitter social media tweets using an Application Programming Interface (API) provided by Twitter developers. Through scraping techniques or data collection stages, this study used Orange Data Mining software to collect tweet data about climate action from July 14-21, 2022. The results of study revealed that there are four issues discussed by the younger generation regarding climate action on Twitter including: the core issues about climate change and global warming, urgency on climate action, attention to the causes and consequences, and responsibility and solutions to climate change through the climate action movement. Sentiment analysis showed that 74.42% (6,716 tweets) expressed positive sentiment toward climate action, while 25.58% (2,308 tweets) expressed negative sentiment. The implication of this research for framing theory is that the dominant frame in public discourse can influence policy acceptance and collective action. Policymakers and communicators can strategically reinforce constructive frames for young people, such as economic opportunity, equity, and innovation, to broaden youth engagement while reducing resistance to the impacts of climate change. As the largest Muslim country, the results of this study provide an important contribution to the internal dynamics of religious environmental activism among the younger generation in responding to the environmental and climate crisis.

Keywords: climate action, twitter, sentiment analysis, topic modelling.

INTRODUCTION

Climate change is a multidimensional issue that impacts all aspects of society, including public health and human rights. The magnitude of the global impacts of climate change is outlined in one of the Global Goals of the Sustainable Development Agenda (United Nations, 2025).

The impacts of climate change can be mitigated by focusing on equity and building the resilience of the most vulnerable groups, including young people, namely children and adolescents (Sato et al., 2017). Synergy between various parties is needed to realize common goals in the sustainable development agenda. The involvement of various groups of people and communities, including local communities, marginalized communities, women, and youth, is also an important concern that emphasizes the achievement of the goals of this global agenda.

Concerns about climate change are increasing in many countries, but individuals still struggle to translate their concerns about climate change into concrete actions (Hochachka, 2024). Problems caused by climate change impact the well-being of young people (MacKay et al., 2020). Zimba et al., (2021) identified significant gaps and barriers in current stakeholder engagement activities that contribute to the marginalization of young people in climate action planning processes.

Participation in volunteer activities to raise awareness among individuals is a form of climate action that correlates with concern about climate change (Kurt & Akdur, 2024). Youth concern about climate change is crucial, given that they are the population most impacted by future climate change. Environmental awareness and healthy levels of climate anxiety can fuel climate action among young people (Aruta, 2025). Youth engagement in climate action is growing globally. The increasing involvement of young people in various climate strategy developments initiated by the government and the private sector demonstrates dedication to youth involvement (Rizka Luthfia & Luthfia, 2025). Not only driven by organizations with established environments, but collective action on climate issues is currently also dominated by groups, communities, and even individuals (Hestres & Hopke, 2017). Furthermore, youth involvement and attention to climate issues have also fueled the emergence of various campaigns and movements on online communication platforms, known as digital activism.

Currently, youth activism in climate action can be identified primarily on social media platforms. Technological advancements and the widespread use of various online communication platforms have opened up opportunities for digital activism based on various issues and movements, including actions related to climate change. In many cases, youth digital climate activism has mobilized communities to push for various changes. Social media has facilitated bottom-up change by enabling global activists to communicate and organize movements more effectively (Jacqmarcq, 2017). Among various social media platforms, Twitter is one platform that facilitates the emergence of digital activism related to climate action initiated by young people. Posts and conversations shared by young people on Twitter can represent young people's opinions and attitudes towards climate change issues. Data also shows that young people dominate Twitter users; 62.5% of Twitter users worldwide are young people under 35 (We are Social, 2022). Unlike social media platforms like Instagram and Facebook, Twitter provides more concise and meaningful data to express opinions.

Framing theory (Chong & Druckman, 2007) conceptualizes how communication processes shape individuals' thinking around an issue. Framing theory offers a theoretical

lens that can help illustrate the role of social media in public discourse on climate change and climate action, which in turn can suggest approaches to mitigating the impacts of climate change. Framing theory posits that two primary mechanisms determine the impact and success of framing: (1) how often recipients of a framed message are repeatedly exposed to the same framework (and intent), and (2) how often recipients of a framed message are exposed to a framework that contradicts their previously held views (Chong & Druckman, 2007).

This study analyzes posts and conversations about climate action on Twitter using sentiment analysis techniques to obtain opinions from Twitter users regarding climate action. Similar research has been conducted in India, Australia, and Peru. (Kumar et al., 2025a) examined Indian public discourse and sentiment regarding climate action on social media between 2015 and 2023. Ruiz-Dodobara et al., (2024) examined the relationship between social media use and collective environmental action among students in Peru. Meanwhile, Arnot et al. (2024) examined youth perspectives on the role of social media in climate awareness, action, and policy change in Australia. This study differs from previous research in that it used Orange data mining software for data analysis, including topic modeling to automatically extract various discussion topics and sentiment analysis to classify tweets as positive, neutral, or negative.

Topic modeling and volume analysis can be used to analyze discussions across regions or time periods, and sentiment analysis is useful for determining the emotional states or opinions expressed in a data set (Dahal et al., 2019). Sentiment analysis analyzes events from opinions based on a person's attitude toward an object. Sentiment analysis is typically conducted to collect and examine public opinion on blog posts, Twitter, Facebook, and other social media platforms. Sentiment analysis is necessary to determine public opinion about an object. This opinion can be negative or positive depending on how the public views the issue (Fahmi et al., 2023). As a country with the largest Muslim population in the world, the results of this study can provide an important contribution to the internal dynamics of environmental activism among the younger generation of Indonesian Muslims in response to the environmental and climate crisis.

METHODS

This research uses a quantitative descriptive research approach. Orange data mining is used for data analysis and visualization tools including sentiment analysis, topic modeling and word clouds. Orange Data Mining is an open-source software for data processing, data visualization, machine learning, and data mining or data mining written in Python (Mohi, 2020). The use of Orange Data Mining displays the Design Widget Text Clustering, which is presented in the process flow as shown below.

Data Collecting Method

This research collects data from people's tweets on Twitter social media, in collecting the data using the Application Programming Interface (API) that the Twitter developer has provided. Through the scraping technique or data collection stage, this research uses Orange software by taking tweet data for one week (July 14-21, 2022), producing 9024 data tweets

that discuss climate action. Twitter was chosen because the majority of its users are <35 years old (62.5% of users). Posts and conversations shared by young people on Twitter can represent young people's opinions and attitudes towards climate action.

Data Analysis

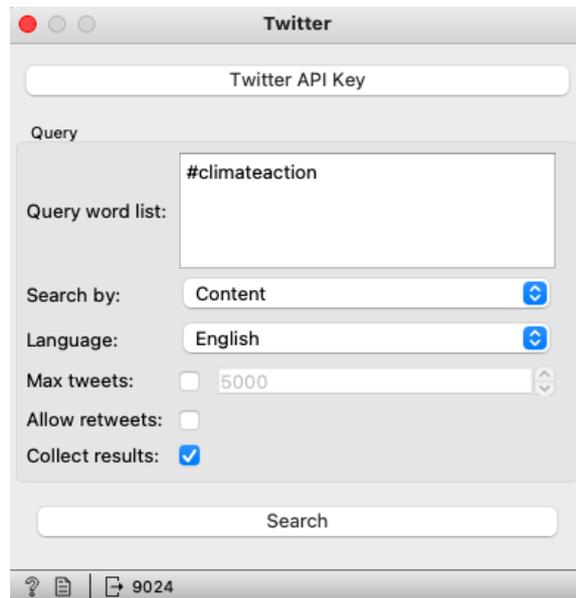


Figure 2. Tweet query using Orange Data Mining

a. Preprocessing Data

The data preprocessing steps performed in this study include:

Transformations: converting all text to lowercase (to ensure uniformity), de-accenting (removing diacritics and accents to standardize characters and facilitate cleaner text representation), parsing HTML (detecting and removing HTML tags), and removing URLs (extracting URLs from text to reduce clutter and focus on the core content)(Neogi et al., 2021).

Tokenization: breaking text into individual words or phrases to facilitate processing and analysis. Regexp (separates text based on a given regex, by default the separation is based only on words, ignoring punctuation)(Rahman et al., 2024). By default, Regular Expression or Regexp in Orange Data Mining is set to remove punctuation marks that have no weight or essential role in the analysis process. Table 1 shows the number of punctuation marks and numbers that will be removed from the data.

appearance of the word cloud was still dominated by symbols and words that were not related to climate action. To overcome this, this study applies several data pre-processing stages, namely tokenization, transformation, and filtering.

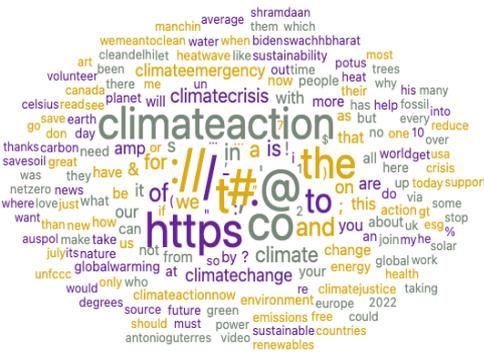


Figure 4. Word Cloud visualization on the “Climate Action” issue before *Pre-Processing stage*
 Source: Data Analysis, 2023

After the pre-processing stage, the data can be viewed as a collection of words with the help of Word Cloud visualization in Orange Data Mining software, as shown in Figure 3. The most frequently appearing words include climate emergency, change, environment, action, need, energy, sustainability, people, world, and joining. Figure 3 shows a Word Cloud visualization on the Climate Action issue.



Figure 5. Word Cloud visualization on the “Climate Action” issue after *Pre-Processing stage*
 Source: Data Analysis, 2023

The word cloud visualization results show that there are four issues discussed by the younger generation regarding climate action on Twitter. "Climate change" and "global warming" are the core issues garnering attention from Twitter users. This indicates that the

dataset focuses heavily on the overall climate change discourse. "Global warming" emphasizes temperature rise as the core issue of concern.

High levels of concern and urgency are demonstrated by the emergence of words such as "emergency," "impact," "future," "world," and "action." This demonstrates the global youth's concern for climate change. The discussion frames climate change as an urgent global crisis, rather than a distant and low-probability issue. The discussion also focuses on the environment and ecology. Frequently used terms include "emissions," "carbon," "energy," "renewable," "greenhouse," "biodiversity," "ecosystem," "nature," "forest," "water," and "animals." This demonstrates the younger generation's attention to the causes (carbon emissions, fossil fuels) and consequences (biodiversity loss, ecosystem damage), as well as the need for concrete action to mitigate the risks through climate action. The young generation's responsibility and solutions to climate change are manifested in the climate action movement. Discussed mitigation strategies and solutions are reflected in the emergence of words such as "sustainability," "renewable," "action," "government," "policy," and "transition." Discussions about mitigation solutions and strategies are reflected in the emergence of words such as "renewable" and "energy." Younger generations are beginning to focus on the transition to clean energy. Climate action is seen by Twitter users as an effective way to reduce the damage caused by climate change.

2. Sentiment Analysis

In this analysis, Vader will categorize and give a text score based on the value of each word listed in Vader's lexicon.

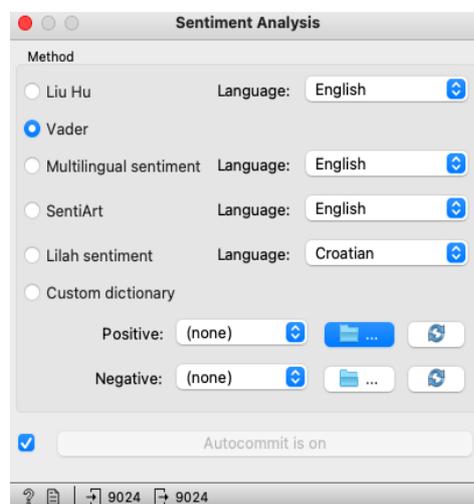


Figure 6. *Sentiment Analysis*

Source: Data Analysis, 2023

The results of the sentiment analysis show that the issue of climate action on Twitter has a positive sentiment of 74.42% (6716 tweets) and 25.58% negative sentiment (2308 tweets). The following figure presents the sentiment distribution on the climate action issue. Sentiment analysis showed that 74.42% (6,716 tweets) expressed positive

sentiment toward climate action, while 25.58% (2,308 tweets) expressed negative sentiment.

This indicates that the majority of Twitter users in the dataset expressed a supportive attitude toward climate action. In contrast to public sentiment regarding climate action, research in Malaysia by (Taufek et al., 2021) revealed that the majority of public sentiment on climate change issues appears negative. This suggests that younger generations are more supportive of climate change action and concrete actions as solutions to mitigate its impacts. The predominance of positive sentiment in climate action indicates that climate action is generally considered necessary and beneficial, and urgent. However, the presence of negative sentiment, representing more than a quarter, indicates that young people still harbor skepticism, opposition, or concerns about public discourse related to climate action. This results aligns with (Kumar et al., 2025b) findings in India, which revealed that social media is useful for supporting climate change campaign messages, raising public awareness, and connecting diverse viewpoints. Overall, the results of this study demonstrate strong public support, but also highlight ongoing debate and resistance surrounding climate action initiatives globally.

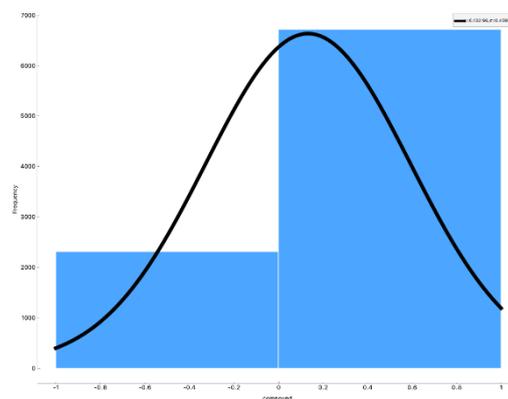


Figure 7. The distribution of Sentiment Analysis on the “climate action” issue
Source: Data Analysis, 2023

The heat map shows the distribution of compound scores on climate action issues ranging from -0.868412 to 0.999851. The yellow color indicates a more positive compound score, while the blue color shows a more negative compound score.

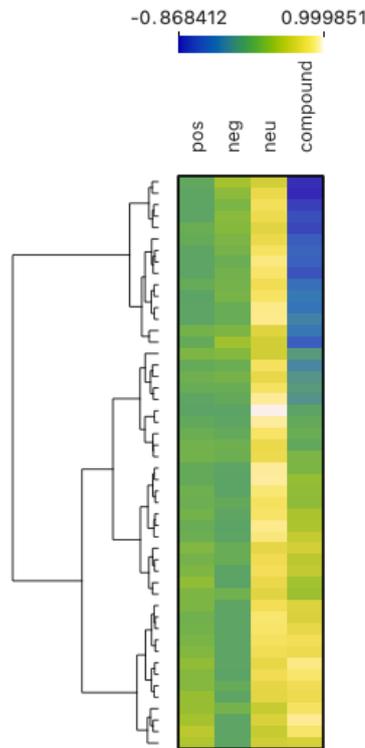


Figure 8. Heat map sentiment on the “climate action” issue
Source: Data Analysis, 2023

Furthermore, Figure 9 and Figure 10 consecutively show examples of tweets with positive and negative sentiments.

compound: 0.6369
Content: It's everywhere...everyone please stay safe #heatwave #wildfires #ClimateEmergency #ClimateCrisis #ClimateAction <https://t.co/kCC6x1LHpU>

compound: 0.6808
Content: Hopefully this will be useful in future #ClimateAction <https://t.co/hby5aVh2CW>

compound: 0.8858
Content: I'm currently reading #allwecansave Truth, Courage, and Solutions for the Climate Crisis by @ayanaeliza to get inspiration and perspective about effective #climateaction. A book a highly recommend

Figure 9. Tweets of Positive Sentiments

Source: Data Analysis, 2023

compound: -0.8832
Content: A 3 min PRIVATE JET trip?! Ban that shit. Such a waste. #ClimateAction #TaxTheRich <https://t.co/zvo53RHcP2>

compound: -0.8955
Content: @climat_change @_GlobalCrisis_ People die without taking part in hostilities. Isn't this proof that #climate is the only enemy of mankind! #Heat #Spain #ClimateCrisis #ClimateAction

compound: -0.8402
Content: @PressSec #inflation is only part of it. A rogue #SCOTUS, the failure to end the filibuster & pass #ClimateAction, #bbb, deal with #StudentDebtCrisis, pass #VotingRights etc. And @POTUS visits countries that murder US citizens & permanent residents with impunity. #disappointed <https://t.co/VlyXKh1v6k>

Figure 10. Tweets of Negative

Source: Data Analysis, 2023

3. Topic Modelling

Apart from conducting sentiment analysis, this study also analyzed topic modeling. To see what topics are discussed in searches using the keyword climate action, the ten topics that appear are as follows:

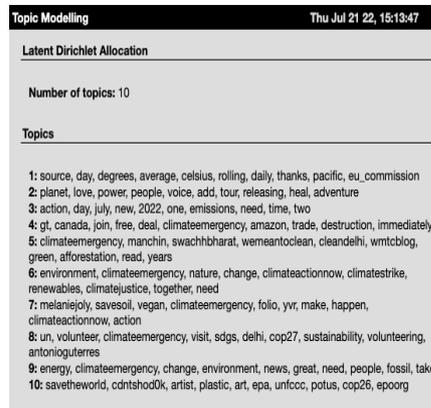


Figure 11. Ten topics appearing on the “climate action”

Source: Data Analysis, 2023

Topic modeling results indicate that discussions related to climate action on Twitter revolve around several interrelated themes, including environmental protection, renewable energy, emissions reduction, policy and governance, climate justice, and sustainable development. Keywords such as renewable energy, carbon, emissions, net zero, sustainability, climate policy, transition, and justice demonstrate that the discourse is not limited to recognizing climate change as a problem but extends to solutions and systemic transformation. Young people are attempting to discuss concrete actions to address climate change-related issues. The presence of terms related to governance (e.g., policy, government, action, global, agreement) indicates that institutional responsibility and international cooperation play a role in the sustainability of climate action. Furthermore, terms related to environmental impacts (e.g., flood, drought, forest, biodiversity, ocean) highlight young people's concerns about ecological consequences, reinforcing the urgency reflected in public discourse. In line with the findings of this study, Arnot et al., (2024) revealed that social media presents a powerful and inclusive opportunity to engage young people in discussions and decisions made about the climate crisis.

Discussion

The results of this study can be interpreted through the lens of Framing Theory (Chong & Druckman, 2007), which states that the way issues are presented (framed) influences how audiences understand the problem, assign responsibility, and formulate solutions for reducing climate change risks through climate action. Topics identified from discussions among Twitter users, such as renewable energy, carbon emissions, net zero, sustainability, climate justice, policy, and environmental impact, indicate that climate action is framed not only as an environmental issue but also as a global socio-political and economic challenge.

Framing related to policy, government, agreements, and transition reflects a framework of governance and responsibility. Institutional actors are positioned as key agents of change. The biggest criticism of social media platforms by young people in Arnot's research is that they still don't help them reach relevant decision-makers. Structural and institutional barriers hinder young people's participation in responding to the climate crisis. Similarly, the inclusion of terms related to impacts such as floods, droughts, biodiversity, and oceans aligns with the framework of environmental risks and consequences of climate change, which emphasizes the urgency of concrete action to reduce vulnerability to climate change.

Framing climate change not only as a crisis but also emphasizes transformation, equity, and opportunities to address its impacts. The presence of terms such as justice, transition, sustainability, and renewable energy in discussions related to climate action demonstrates a solution-oriented and justice-based approach. The climate action movement has created new ways of thinking about power and voice among young people (MacKay et al., 2020)(Mackay). According to framing theory, this framework can shape young people's perceptions by increasing support for climate policies when the issue is framed as urgent and solvable.

CONCLUSION

This study analyzes posts and conversations about climate action on Twitter using sentiment analysis techniques to obtain opinions from Twitter users regarding climate action. The conclusions from this research are as follows:

1. The word cloud visualization results show that there are four issues discussed by the younger generation regarding climate action on Twitter including: the core issues, High levels of concern and urgency on climate action, attention to the causes and consequences, and responsibility and solutions to climate change through the climate action movement.
2. Sentiment analysis showed that 74.42% (6,716 tweets) expressed positive sentiment toward climate action, while 25.58% (2,308 tweets) expressed negative sentiment. Overall, the results of this study demonstrate strong public support, but also highlight ongoing debate and resistance surrounding climate action initiatives globally.
3. Topic modeling results indicate that discussions related to climate action on Twitter revolve around several interrelated themes, including environmental protection, renewable energy, emissions reduction, policy and governance, climate justice, and sustainable development.

The implication of these research findings for framing theory is that dominant frames in public discourse can influence policy acceptance and collective action. Policymakers and communicators can strategically reinforce constructive frames for young people, such as economic opportunity, equity, and innovation, to broaden youth engagement while reducing resistance to the impacts of climate change.

Declaration of AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the authors used Mendeley for reference formatting and Orange Data Mining for data analysis and visualization. After using these tools, the authors

reviewed and edited the content as needed and take full responsibility for the integrity, accuracy, and originality of the publication's final version.

CRedit Authorship Contribution Statement

Authorship contributions are reported following the CRedit (Contributor Roles Taxonomy) system. Each author's specific role in the research and writing process should be identified clearly.

Example Format:

- a. **Resti Kinanthi:** Conceptualization, Data Curation, Formal Analysis, Investigation, Writing Original Draft
- b. **Nindyta Aisyah Dwityas :** Supervision, Validation, Project Administration, and Writing Review & Editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. *If conflicts exist, clearly describe them here.*

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Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available due to privacy restrictions regarding Twitter's social media data policies, but are available from the corresponding author (restikinanthi@gmail.com) upon reasonable request.

Funding Statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethical Approval Statement

The authors confirm that this study adheres to ethical research standards. This research involves the analysis of public social media content (Twitter/X) through data mining techniques and does not involve direct interaction with human participants or patient-identifying information; therefore, formal ethical approval was not required. The data presentation has been anonymized to protect user privacy.

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