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# Digital Dialogues on Plastic: A Twitter/X-Based Textual and Sentiment Analysis of Environmental Discourse

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**Abstract**
World Earth Day 2024 was celebrated with the theme that focusses on finding solutions to plastic pollution under the campaign" Planet vs. Plastics". Scientific papers, newspaper articles, television channels and social media platforms have extensively debated about the consequences of plastic pollution. The findings projected in scientific papers and reports may be incomprehensible for the public. However, social media platforms allow people belonging to diverse backgrounds to share information and express their opinion. Twitter/X has emerged as an important source of data for doing research about pressing issues and recent developments. The present research employs keyword-based filter, ensuring that only tweets containing the defined keyword 'Plastic' were collected, which refined the dataset to align closely with the research focus. This research examines the kind of attention the idea of combating plastic pollution has drawn from people in the form of tweets. Through textual analysis, this paper attempts to explore public discourse surrounding plastic use on Twitter/X and sentiments expressed towards achieving a plastic-free world. By focussing on discussion about current theme of World Earth Day, this paper examines extent of discussion about 'Plastic' during Earth Month, and frequently used terms that emerged from twitter content. Tweets were also analysed to uncover the most frequently used hashtags in tweets containing selected keywords. The most frequently occurring hashtags were related to the category of political campaigns, climate concern and societal responsibility towards environment.

**Keywords**: Plastic pollution, Twitter/X hashtags, Sentiment analysis, Climate concern

## INTRODUCTION

Without doubt, climate change has emerged as one of the most alarming issues facing humanity. The need to take action in order to maintain the integrity of human and environmental systems has long been recognized by most political leaders, business leaders, activists and the scientific community (Arlt et al., 2018; Swyngedouw, 2010).

One of the most serious climate challenges to have emerged in recent history is plastic pollution. It is the concept of plastic free that is also the fastest rising search terms in the last few months (Google Trends, 2019). Plastic wastes have become a serious climate change hazard which is responsible for accelerating the climate change. Plastic products are non-biodegradable as they don't degrade over a period of time

and can remain present in the climate for thousands of years. The resistance to degradation increases the risk of their accumulation (UNEP, 2017). The harmful effects of plastic waste accumulation especially micro plastics, include harm to the climate in the form of land, water and air pollution, destructive impact on the natural environment (Adane and Muleta, 2011), contamination of groundwater, blockage of sewage, negative impact on human health, (Ellis et al., 2005) death of animals due to blockage and starvation (Verghese et al., 2006). Furthermore, the process of plastic production is accelerating climate change and leads to air pollution and global warming. One of the most overriding concern is that "the annual production of plastic in the world has become more than 300 million metric tons" (North and Halden, 2013). Plastic waste accumulation is persistent and pervasive source of marine pollution (Wu et al., 2016) The damage caused by unsustainable use and disposal of plastic products, especially single use plastic to our ecosystems and India's large-scale endeavours towards wiping out single use plastic, have been highlighted and discussed at many international forums including climate summit and G7 summit. According to Central Pollution Control Board (2021), India is generating 4,126,997 tonnes of plastic waste per annum. About 40 percent of plastic waste in India is neither recycled nor collected and leads to contamination of water and land. Like a significant part of the world, India is attempting to dispose its growing amounts of plastic waste given how pervasive it has become- from our debit cards to toothbrushes. Undisposed plastic waste accumulates on our land or ends up in our oceans and other water resources. Plastic toxins and debris represent a serious challenge for remediation (Derraik, 2002; Zarfl et al., 2011).

The discussion about the magnitude of plastic pollution carried to sea has significantly multiplied in India recently. According to United Nations Environment Programme (2025), plastic pollution has emerged as a critical global issue, with an estimated 19 to 23 million tonnes of plastic waste entering aquatic ecosystems annually, contaminating rivers, lakes and oceans. The present research focuses on Twitter/X data to analyze public discourse regarding plastic use and sentiments towards achieving a plastic-free world by examining variations in the specific words used by users on the platform. This research focuses on tweets posted by Twitter/X users between April 1$^{st}$, and April 30$^{th}$, 2024 which incorporated the term 'Plastic'. Research objectives examine the content of tweets posted using the term 'Plastic' by people in Delhi National capital region. We collected data over the course of a month that included Earth Day, as this period was particularly relevant to my research. The theme for Earth Day 2024 – 'Planet vs. Plastics'- aligned closely with the focus of our study.

From the past few years, Twitter/X has become an important source for user generated content and offers an effective way of sharing the perspective of users towards various issues in different domains. This microblogging platform enables users to read and post messages or information within 280 characters. Twitter/X has opened entryways for researchers in the field of analysis. Twitter/X provides an important platform to start petitions for a specific cause, disseminate messages or information and gather support (O'Reilly & Milstein, 2011).

The limitations due to the brevity of tweets make creation and consumption of content less tedious for creators and readers. Notwithstanding the constrained length of tweets, people, organizations, politicians and activists are actively utilizing Twitter/X data to reach and convey their message to the large number of people (Himelboim et al., 2013). Twitter/X is estimated to have more than 300 million regular Twitter/X users and 500 million accounts as per Twitter/X CEO Dick Costolo (Holt, 2013). This social network platform has turned into a significant resource for journalism researchers and facilitates journalistic activities (Burgess and Bruns, 2012). According to O'Reilly and Milstein (2011), organizations can

discover public opinion about their products, respond to the queries posed by customers or prospects, run promotional activities and engage with stakeholders by using social media platforms. As far as socialization aspect is concerned, social media platforms allow people to get more information about pressing issues and engage with each other (Allan, 2007). In the same way, government can find out what people think about its policies, campaigns and decisions through Twitter/X based research. "Social media platforms like Twitter/X allow people to mobilize support for an initiative and create virtually connected communities consisting of people with similar opinion" (Carew, 2015).

Social media is an important source of climate information that has not been vigorously analyzed. In the last decade, a transition in the media consumption patterns has been observed. This change represents a shift in the pattern of communication from "one to many" to "many to many" (Boykoff, 2011). Social networking platforms like Twitter/X offer a system for people belonging to varied backgrounds to share and form their opinion about different issues rather than a single expert or journalist telling people what to think about. Exposure to information can be considered an important aspect. It is a precondition to create awareness and turn a social problem into public issue (Dearing, 1996). Twitter/X is a potential platform where issues pertaining to climate change can be uncovered and discussed.

The present research paper will add to the existing research on social media platforms as a medium to discuss and share opinion about an initiative or issue. This research paper examines the Twitter/X messages posted by users from Delhi National Capital Region who used keyword 'Plastic' to discuss and express their opinion about it on Twitter/X, which will be studied through sentiment analysis. While analyzing the content of tweets, the present research will also trace another interesting aspect of analyzing data from Twitter/X. Frequent words used when discussing and expressing opinion about plastic will also be explored to access underlying sentiments, categories and conceptual blocks among Twitter/X users.

As Twitter/X has become a platform that is increasingly being used by the general public, activists and government to assist their endeavours, the social significance of present research is to understand public discourse on Twitter/X about plastic and uncover major lessons, sentiments and underlying categories that emerged after examining Twitter/X data. The results of this research are important to guide activists, government and general public in their future campaigns and initiatives.

**Social Networks and Public Sphere**

The idea of social networking platforms as a space where different issues can be discussed, explores into German philosopher Jurgen Habermas' concept of public sphere (Habermas, 1991). The present research explored into the Habermas's concept of public sphere and makes an attempt to explore the instances of public sphere in social media platform Twitter/X. Creating public spaces of activism for deliberation is an important precondition for opinion formation and engagement in climate campaigns. Habermas coined the term "public sphere as a place where individuals can come together to freely discuss and identify societal problems and matters of mutual interest and, where possible, reach a common judgment" (Habermas, 1991). It can be defined as a place where different issues of common interest are discussed and public opinion can be formed. It is open to all the citizens and they play the role of a private person who is trying to deal with different matters pertaining to general interest to build a public sphere.

The rise of online social networks is viewed by numerous researchers as other methods for creating a public sphere since this Internet-based correspondence condition can possibly be a forum for an open discussion and has a number of qualities to be "new public sphere" (Jones, 1997). "Social networks can be attributed with fostering a sea of change in how people communicate" (Solberg, 2013). A few

researchers have proposed multifaceted structure with respect to public sphere in order to distinguish new media sphere from the traditional mass media sphere. Downey & Fenton (2003) have presented "two domains of public sphere such as common domain comprising of dominant media and the other one is counter public sphere" which can be considered as public sphere of the dominated. Sources of information for the general public are dominated by mass media in the "common domain" whereas alternative media are utilized by the activists to advance their messages in the "counter-open sphere. Social media helps to democratize the process of knowledge sharing by providing a platform to discuss and express opinion about different topics or issues. (Stassen, 2010). Online social platforms allow democratisation of information sharing because they create a common sphere for discussing different issues (Stassen, 2010). "Online social networks play an important role in generation of microsphere linking the private life and deliberative space for people" (Dahlgren, 2001). "People exchange ideas, look for affiliations; form diasporic communities in this space and discuss the possible solutions" (Pavlik, 1994).

Different types of media tend to affect people in different ways. The usage of social media has led to a new style of journalism where power to disseminate information about different causes and issues rests with public (Romano, 2010). People recognize the issues that are affecting their communities by creating a public sphere of like-minded people. Although social media platforms play an important role in amplifying communication about different issues and campaigns, but the future of an initiative cannot be predicted by using technology or internet-as it is not the digital media or internet that gathered support for the campaign-rather it is just a socially active group of people who use digital media and internet to reach a wider public (Davis, 1999). Social media provide a number of new opportunities for people to transmit text and visual discourses. It helps people to "self-mediate" and assists in initiating debate amongst them. Nowadays social media platforms are being utilized in an extensive manner and work as a crucial part of many social movements for decision making (Gillian, 2008). It helps in understanding the perspective of how online deliberations facilitate the creation of active spaces of public sphere.

Findings from the present research analysis will contribute to (a) growing research in the field of online communication, specifically microblogging site Twitter/X b) growing research into the techniques and methods that are used to study communication and discussion on social media and (c) emerging research into climate change communication.

**Rationale**

The present research attempts to conduct a data driven qualitative analysis and provides in-depth insights about public sentiments and views during the height of plastic free planet discussion on national and international forum. The overall research question is – how Twitter/X users view and engage with the idea of plastic free planet. The findings of this research will be of significance to policymakers and stakeholders.

The research methodology and approach applied in the present research can be adapted to analyse the discourse surrounding other initiatives, campaigns and policies. Misinformation and fake news in social media have emerged as a serious challenge for public and policymakers. It can lead to chaos and confusion among social media users (Bode and Vraga, 2018). This makes it imperative to study the kind of information that is being shared on social media and also understand the sentiments of public about it. This study also attempts to underline the importance of new methods that can be utilized by activists and policymakers to analyse this information. This research expands upon previous research work which has

examined climate initiatives and campaigns on social media (Cody et al., 2015; Carew, 2014; Segerberg & Bennett, 2011).

**Literature review**

Twitter/X has become a popular social media platform for academic research that makes it possible to examine changing social structures, community dynamics online as well as content in networks. There is a significant prior research that has mostly focussed on either the connectivity aspect of tweeting such as collective attention to issues (Sasahara et al, 2014; Segerberg & Bennett, 2011), thematic analysis of Twitter/X content pertaining to different issues (Ahmed et al, 2019), analysis of variation in public sentiments about an issue (Cody et al, 2015) or detection of trending topics on Twitter/X (Aiello et al, 2013). Previous literature has made an attempt to relate Twitter/X sentiment insights to specific events (Marcus et al., 2011; Thelwall et al., 2011; Bollen et al., 2011). The present research is an important step towards understanding the significance of Twitter/X data mining for tracking and analyzing views and sentiments about plastic free world by using the keyword 'Plastic'.

Previously, several efforts have been made by researchers to assess public perception about climate change (Lorenzoni & Pidgeon, 2006; Brody et al., 2008; Feldman et al., 2011; Spence et al., 2011). However, Twitter/X data has not been explored and utilized much for opinion mining about a specific climate concern and initiatives. After careful review of previous literature, it has been found that mostly manual and localized surveys have been used to track public perception about climate change issues (Spence et al., 2011). In the present research, we have tried to explore whether mining the social media may provide a better source for tracking public opinion on climate change issues and initiatives. While manual surveys will remain absolutely necessary, opinion mining of social networking platform's data and automated surveys may offer better outcomes. Manual or localized survey-based research studies are restricted as results are based on a limited number of participants and there is a very high possibility of survey bias in such cases. In certain situations, it may be difficult or troublesome to conduct a survey, social media-based opinion mining may provide authentic and more reliable assessment of public sentiments towards different issues, policies and campaigns. In social sciences research, microblogging site Twitter/X has emerged as a valuable repository of information and public views on different issues. It has become an important source of data for academic research as it provides its data through a number of Application programming interfaces. For many social science researchers who were earlier using surveys or case study methods to understand behaviour and perceptions of people in social media platforms, Twitter/X data provides a new perspective on data collection.

Patterns in Twitter/X data have been identified by applying word frequency and sentiment analysis. Lineman et al. (2015) analysed relative search patterns for two keywords "global warming and climate change" to study level of public awareness. They also analyzed public sentiments associated with the above-mentioned keywords. The level of awareness was assessed by using Google Trends and public database of Google queries. In order to analyze sentiments pertaining to both keywords climate change and global warming, tweets containing these keywords were collected from Twitter/X API. Semantria software that is available on MS Excel spreadsheet application plugin was used to conduct sentiment analysis. Kirilenko and Stepchenkova (2014) examined tweets about two keywords "climate change and global warming" in five languages including German, Spanish, English, Russian and Portuguese. They focused on spatial and temporal distribution of tweets on global warming and climate change. They tried

to comprehend the topography of tweeting and changes in the topics of discussion over a period of time along with daily and weekly patterns of Twitter/X users.

An et al. (2014) examined how climate change perceptions may change with exposure to climate hazards over a period of time. They tried to comprehend whether insights about climate change perceptions are supplemented by Twitter/X data mining? They employed a combination of text mining techniques such as time series analysis and hierarchical sentiment analysis for this research. Hashtags (Huang, 2010), retweets (Boyd,2010) and usernames (Honeycutt and Herring, 2009) have been tracked in previous research in order to study the conversational aspects of Twitter/X. Initially, Honeycutt and Herring (2010) studied the username along with sign @ and attempted to understand the online discourse by focussing on conversational aspect of microblogging site Twitter/X. They inferred that @username plays an important role in highlighting the conversational aspect of tweets and tweets containing @username highlight the conversational aspect of the medium. Their research emphasized that about 90 percent of the tweets that contained @username were conversational. Yardi and Boyd (2010) found that Twitter/X users with similar opinions and beliefs tweet to each other relatively more. They focussed on Twitter/X activity around issues related to abortion where people in favour of right to have a choice tended to tweet to like-minded people. Twitter/X messages represent a largely untapped resource for research on climate change communication and other climatic issues and their value for research is associated with internal infrastructure of Twitter/X which provides access to authentic data through its API and internal architecture of Twitter/X messages is augmented by ample amount of additional information. Domains in Twitter/X data can be classified into two categories: user domain which contains information pertaining to time zone, geographical location, account age and Twitter/X status of the user. The other one is message domain that incorporates the content of tweets and its properties, URL and hashtags (Cheong and Lee, 2010). Besides, it also provides a means of developing a broad understanding of people's perspective and opinion towards an issue.

Pearce et al. (2014) analyzed the nature of discussion on microblogging site Twitter/X. Twitter/X posts were analyzed to find out the most frequently used hashtags when people posted tweets about Intergovernmental panel on climate change report. They used webometric analyst to extract information and thereafter draw inferences about Twitter/X data. They found that hashtags related to "climate science" and "geographical locations" were used most frequently during the discussion about report submitted by the Intergovernmental panel on climate change. They also found out that people tend to interact on Twitter/X with other users who share similar views on climate change. Bruns and Burges (2011) highlighted the importance of hashtags used in Twitter/X posts. They stated that hashtags create ad hoc public around different issues in a large set of overall Twitter/X data. They examined the use of hashtags in context of different case studies. They found that Twitter/X hashtags play an important role in coordinating and unifying distributed discussions on a specific topic. Bruns and Stieglitz (2012) found stable patterns in the use of Twitter/X in context of pressing issues and topics. They identified different types of discussions on various topics that can be observed on Twitter/X.

Carew (2014) focused on #Iam4rhinos conservation campaign and use of Twitter/X during the campaign. He studied the trends that emerged over the course of 10 days initiative. While using #Iam4rhinos Twitter/X campaign as a case study, he examined the online climate activism scenario in South Africa. He emphasized on the importance of retweets in message diffusion and also highlighted the role of active Twitter/X users and networked action in making this campaign successful. In his research, regular Twitter/X users emerged as prominent influencers during the above-mentioned initiative. Satchwell

(2012) used a variety of methods to examine children's comprehension of climate change. He focussed on Twitter/X discussions to analyse and understand the perspective of children on climate change.
Bosh (2012) compared the blogs of the journalists of two newspapers "The Mail" and "The Guardian" with Twitter/X messages in order to analyze the amount of coverage given to climate change in South Africa. Bruns and Burgess (2011) analysed public discussions on Twitter/X during Australian elections that were held in 2010. They found out that climate change was one of the most frequently discussed topics during the elections.
The literature has been reviewed carefully and it points out that inadequate attention has been paid to Twitter/X data for opinion mining about campaigns or initiatives pertaining to plastic use. The present research analyses the content extracted from microblogging site Twitter/X using R in order to fill the above-mentioned gap in the existing body of literature. Nowadays, it has become possible to empirically analyze online discussions and overall user generated content using the new tools of data collection and analysis (Brossard & Scheufele, 2013). In this research, I have analyzed data drawn from Twitter/X which is a major repository of data for research in social sciences where users can discuss pressing issues as well as personal matters (Hermida, 2013; Kwak, Lee, Park, & Moon, 2010; Veltri, 2013).

**Methodology-**

**Research Objectives**

- To understand how Indian Twitter/X users view and engage with the idea of achieving a plastic-free world.
- To provide an exploration of the sentiments surrounding tweets containing the keyword 'Plastic'.

**Research Questions**

- What are the frequently used terms in expression of public opinion about plastic usage?
- How collective sentiments of public vary in response to information and news about plastic usage?
- What are the most frequently used hashtags in tweets containing keywords 'Plastic'?

**Research approach**

The present research is based on Twitter/X data that was retrieved via Rest API. This study seeks to examine the information and sentiments surrounding plastic usage, as reflected in user-generated content on Twitter/X during a 30-day period. The Twitter/X data has been analysed through sentiment analysis using sentiment analyser. The present study is pragmatic and has used the methods which appear best suited to derive answers to the research questions. The process of methodological implementation has been divided into 3 stages: 1) Data collection from Twitter/X using R 2) Pre-processing of data 3) Textal analysis

**Data collection**

Data was collected corresponding across a time frame of April 1, 2024 till April 30, 2024 using the keyword 'Plastic'. The selected time frame was chosen to align with key environmental dates-Earth Day on April 22 and Plastic Overshoot Day of India on April 23-which are highly relevant to the study's focus on plastic use and public awareness. Plastic overshoot day represents the day when a country has generated more plastic waste than it can manage in a sustainable manner which highlights the gap between plastic usage and waste management capacity. The theme of Earth Day 2024, 'Planet vs. Plastics', corresponds

closely with the central concerns of this study. The month in which Earth Day falls is particularly relevant, as public discourse surrounding the earth day theme and broader climate related concerns offers a dense and diverse pool of meaningful data, reflecting public awareness and sentiments. We have accessed Rest API to fetch the Twitter/X data. We need to have information about the four keys in order to access Rest API : consumer key, consumer secret key, access token and access token secret. After getting access to Twitter/X Rest API, it was linked to R library by using rtweet to fetch the tweets. Geocode has been used to filter tweets based on location as the present research focusses on tweets posted by Twitter/X users of Delhi NCR. Twitter/X data has been extracted and stored for the completion of first phase. In total, there were n = 10000 tweets. A 10% simple random sample ($n$ = 1000) of the filtered data of tweets was chosen to conduct sentiment analysis.

**Data pre-processing**

In the 2nd stage, relevant information has been filtered by applying pre-processing methods. Tweets that constitute raw data are quite unstructured and noisy. Quality of data has a direct impact on the results and research findings. Pre-processing methods have been applied to improve the quality of Twitter/X data. Data pre-processing methods can be classified mainly into four categories: data cleaning, data integration, data transformation and data reduction. In the present paper, data cleaning has been used for filtering out inconsistent and redundant data.

**Text mining**

This research employs text mining techniques to analyze data. it can be defined as a process of identifying patterns, keywords, concepts and other attributes in the large amounts of text data. The text mining is a little different from data mining as it focuses on text instead of more structured data. Text mining techniques are as follows -:

1) Categorization 2) Clustering 3) Information extraction 4) Visualization.

There is a need for some mechanism to overcome the problem of unstructured raw data. the solution to the above cited problem is “information extraction”. the process of text mining starts with organizing and structuring the data in some fashion so as to make sure that it can be subjected to qualitative and quantitative analysis. It utilizes computational linguistic principles to interpret and parse Twitter/X data by using natural language processing technology (NLP).

**Sentiment Analysis**

It is widely used to get insights from social media data and survey responses. It helps to understand the opinions expressed in text and detect polarity of large sets of textual data. Sentiment analysis can be defined as a type text research that incorporates the process of computationally identifying sentiments expressed in a piece of text in order to determine people’s attitude towards an issue. It uses a blend of natural language processing (NLP), artificial intelligence and statistics to understand and identify subjective information pertaining to a person’s thoughts and assessments about a specific issue or organization. This type of qualitative analysis is also known as opinion mining or sentiment extraction and classification. In the present research, it will allow us to track the underlying sentiments of Twitter/X users about plastic usage. Depending on the research goals, two analysis types can be used: coarse-grained and fine-grained. Coarse-grained analysis allows for defining a sentiment on a document or sentence level. The present research uses fine-grained analysis, where we can extract a sentiment in each of the sentence

parts. This research employs Excel add-in that enables to carry out sentiment analysis on textual data within an Excel spreadsheet. It uses advanced lexicon-based approach to sentiment analysis. This analysis also gives us the most popular terms used by Twitter/X users to discuss and express their opinion about plastic free planet. Word clouds have been generated to visualize the analysis. The size of each word is proportional to the number of times it has been repeated in the Twitter/X messages.

**Data Analysis**

Sentiment analysis is a process of computational assessment of opinions expressed in text and helps in determining whether the nature of opinion is positive, negative or neutral. Cody et al. (2015) stated that comments or text shared on Twitter/X is emotionally loaded due to its textually shortened nature. Nasukawa and Yi (2003) stated that sentiment analysis identifies sentiments expressed in different statements and also classifies statements on the basis of their polarity. The spectrum of sentiment analysis techniques goes from computational treatment of subjective information or conversation, sentiment and opinion to identification of polarity (positive, negative or neutral). Specifically, the research on polarity of text and sentiment analysis has led to the availability of various openly accessible instruments or tools such as Alchemy, SentiStrength, Stanford NLP sentiment analyser and NLTK.

Sentiment analysis was conducted using Sentiment analysis tool which is available as MS Excel add in. During the process of sentiment analysis, every sentence of textual data is divided into different parts of text. Thereafter, it identifies sentiment laden words from textual data and leads to generation of a set of numeric scores which help in tabulating the sentiment score for textual data. thereafter, tweets with different numerical values were assigned a polarity label such as positive, negative or neutral. This tool analyses the textual data and generates 1) a colour coded copy of text to indicate positive or negative sentiments found 2) Positive and Negative sentiment score: it indicates the extent of positive or negative sentiments in the tweets 3) Polarity label: it shows whether net score is positive, negative or neutral. Sentiment score is neutral when there are both positive and negative words in the textual data and scores for each are similar. A label of “no sentiment” means that no sentiment was found in the text. 4) Total tweets processed: pie chart presents the sentiment classification groups (Positive, Negative, Neutral, No sentiment) from the processed data in a summarized form. 5) Word cloud: it presents the sentiment laden words from tweets. The polarity is indicated by the colour of the word (Green= positive and Red= negative). The different shades of green and red colour help in visual representation of different words that have the same polarity. 6) Net sentiment: bar graph shows the proportion of sentiments laden tweets from data, along with Net sentiment score which is calculated by using the following formula:

$$\left(\frac{\text{Number of text items with POSITIVE Net score}}{\text{Total number of text items (positive + negative + neutral)}}\right) - \left(\frac{\text{Number of text items with NEGATIVE Net score}}{\text{Total number of text items (positive + negative + neutral)}}\right) X\ 100$$

7) It also allows us to conduct a frequency analysis of hashtag usage and their distribution.

**Results**

The results of present research have been presented through pie chart, word cloud and bar graphs. These components present the process of sentiment analysis. As depicted in figure 1, pie chart presents a very

generic preview of the results that have been obtained on the basis of analysis. It classifies the percentage of positive, negative and neutral items as per the quantity of tweets present in every classification. Bar graphs display the number of positive, negative or neutral words and their corresponding frequency in tweets. The tabular presentation shows the detailed colour coded data of tweets along with the classification of tweets. Sentiment classification determines the sentiment direction or orientation of the opinions expressed in a tweet. Opinion orientation of text can be understood as categorization in opposing positive or negative polarities along with an option of neutral polarity.

## TOTAL TWEETS PROCESSED

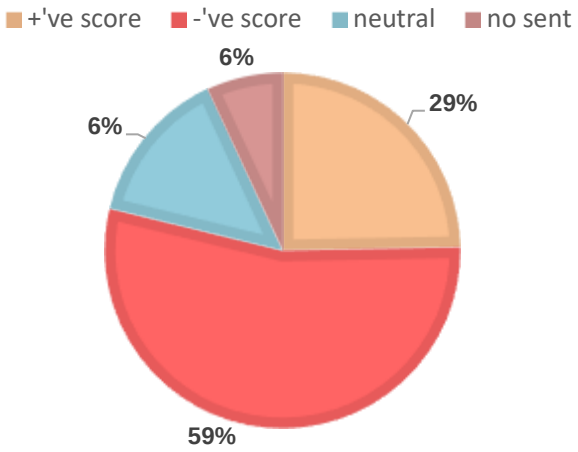


**Figure. 1**

## NET SENTIMENT

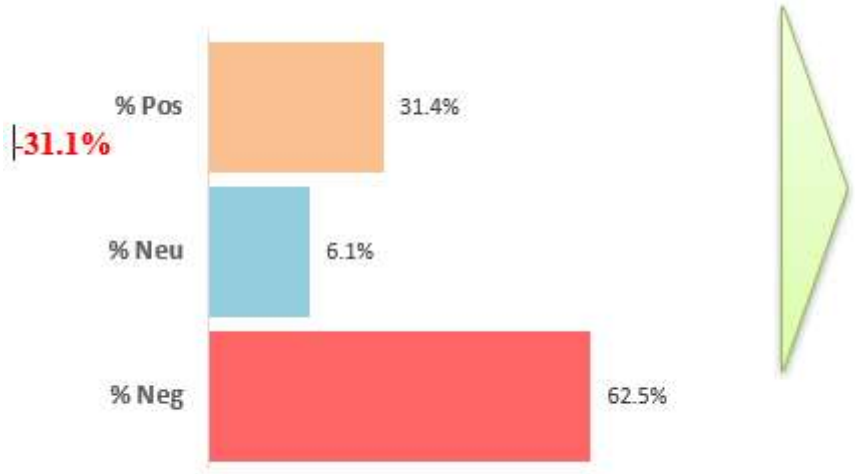


**Figure.2**

| | | +'ve score | -'ve score | neutral | no sent | no data | Overall | Net Sentiment= | (Negative Value) 31.1% |
|---|---|---|---|---|---|---|---|---|---|
| Total Processed | Items | 3041 | 6052 | 583 | 615 | 0 | 10,291 | % Pos | 31.4% |
| Total Processed | Items | 29% | 59% | 6% | 6% | 0% | 100 % | % Neu | 6% |
| | | | | | | | | % Neg | 62.5% |
| Average Number of Words per Tweet | | 35 | 35 | 34 | 29 | | 35 | Total | 9676 |

The sentiment analysis of tweets (Fig-2) shows that people felt very negative about the problem of plastic pollution (Net sentiment = -31.1%). Tweets with the keyword 'Plastic' reflecting negative sentiments via descriptions such as, "burden, impossible, threat, risk, harmful, evil, disastrous, excessive" were 62.5%. Proportion of tweets with neutral sentiments was 6%, While 31.4% of tweets conveyed positive messages with words such as, "cleanliness, awesome, support, cooperate, protect, healthy, excellent." Sentiment classification groups formed on the basis of total number of tweets processed show that negative tweets represented 59% of the total, neutral tweets totalled 6%, positive tweets totalled 29% and 6% tweets fall in the category of "no sentiment".

Figure-3 shows frequently used words containing positive and negative sentiments in a color coded manner. Red text represents words bearing negative sentiments whereas green text represents words bearing positive sentiments.

Figure-4 shows frequently used positive words along with the frequency of their occurrence. Figure-5 shows frequently used negative words and frequency with which they are repeated in tweets.


**Figure-3 Word Cloud - All Sentiments**

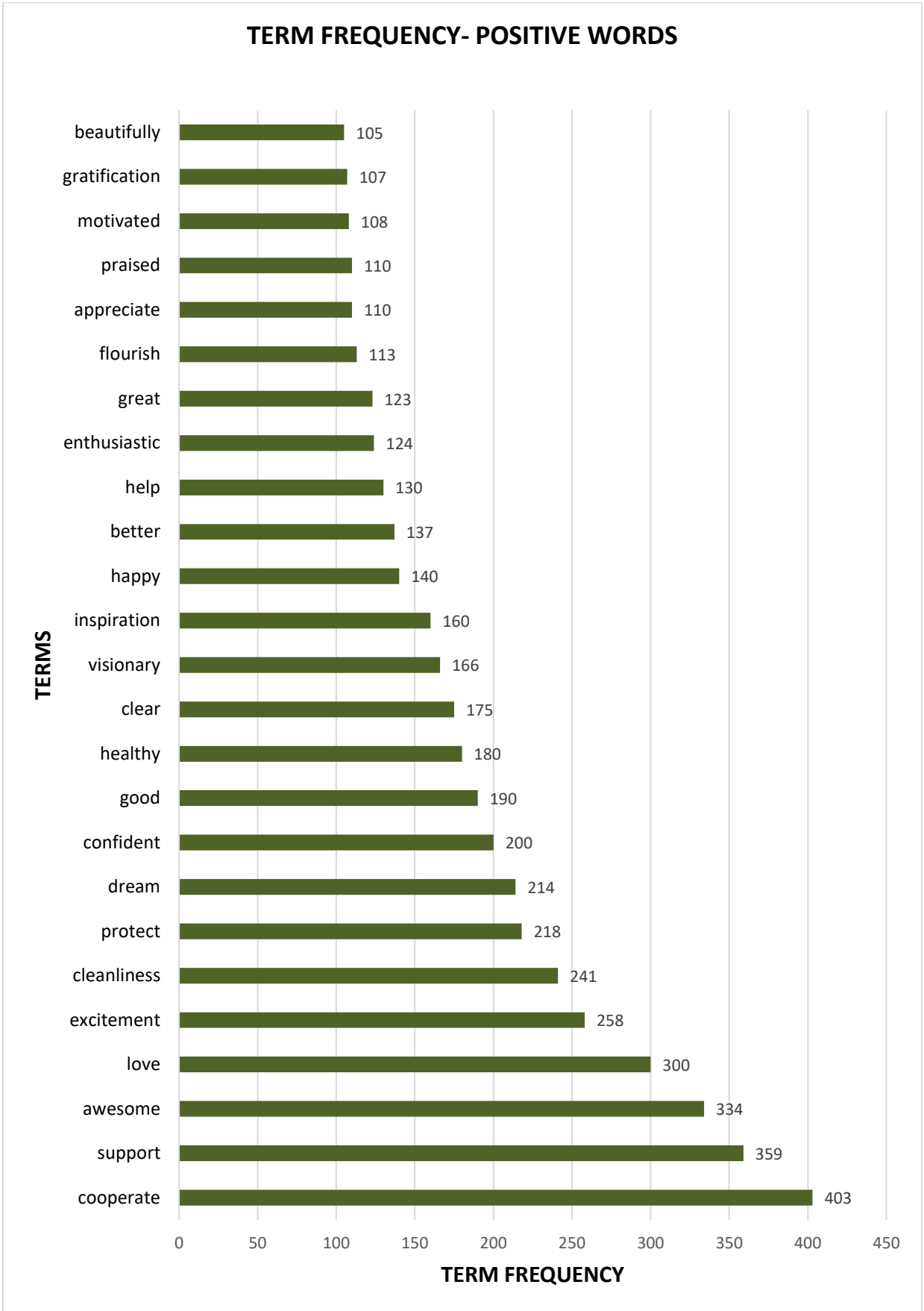
TERM FREQUENCY- POSITIVE WORDS
beautifully 105
gratification 107
motivated 108
praised 110
appreciate 110
flourish 113
great 123
enthusiastic 124
help 130
better 137
happy 140
inspiration 160
visionary 166
clear 175
healthy 180
good 190
confident 200
dream 214
protect 218
cleanliness 241
excitement 258
love 300
awesome 334
support 359
cooperate 403
TERMS
0 50 100 150 200 250 300 350 400 450
TERM FREQUENCY

**Figure-4**

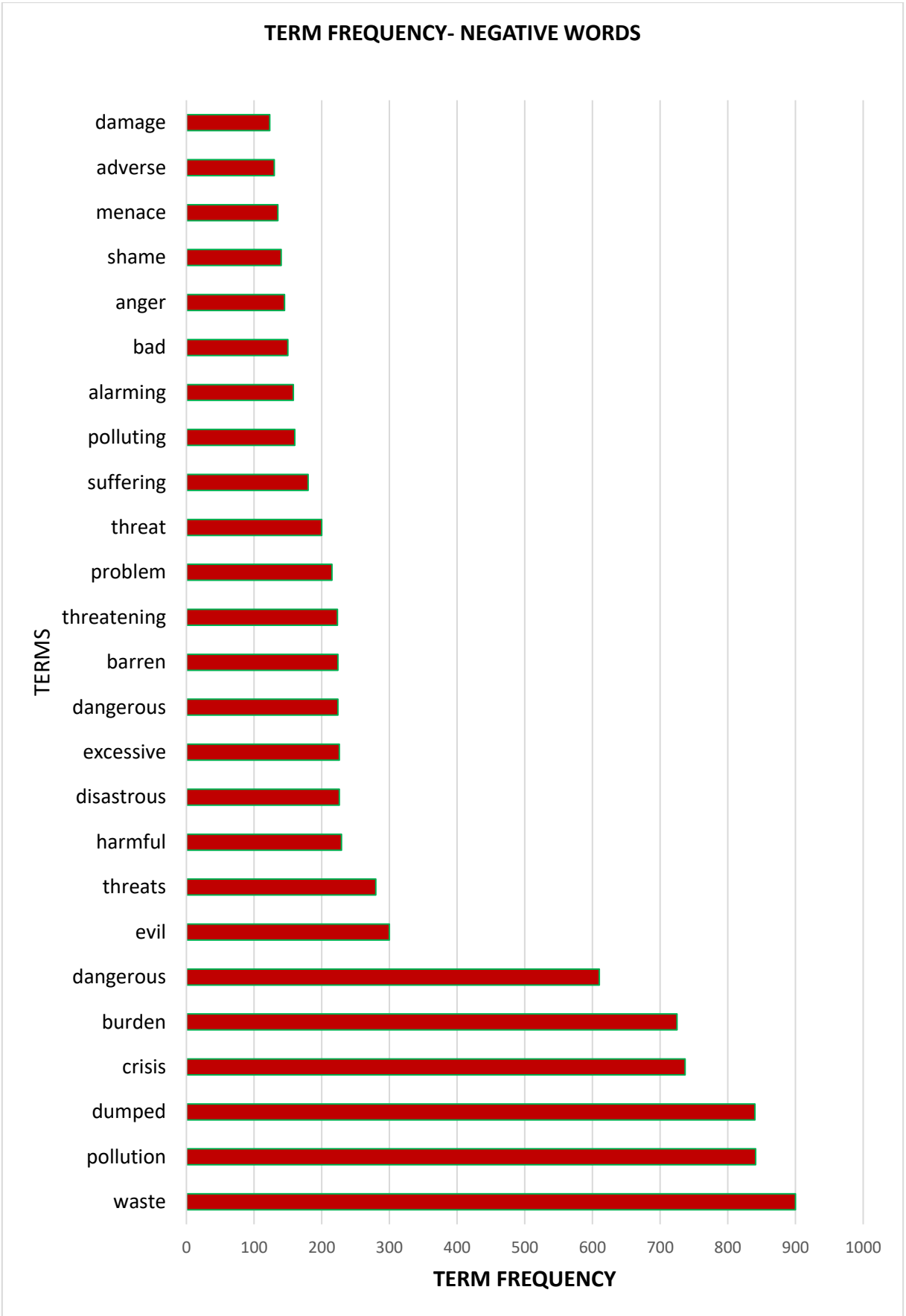
TERM FREQUENCY- NEGATIVE WORDS
damage
adverse
menace
shame
anger
bad
alarming
polluting
suffering
threat
problem
threatening
barren
dangerous
excessive
disastrous
harmful
threats
evil
dangerous
burden
crisis
dumped
pollution
waste
TERMS
0
100
200
300
400
500
600
700
800
900
1000
TERM FREQUENCY

**Figure-5**

**Frequently Used Hashtags and Categories**

The discussion about phasing out single use plastic and idea of plastic free planet has been promoted at many national and international platforms recently. Therefore, it is quite unsurprising that in tweets containing the keyword 'Plastic', frequently occurring six hashtags were associated with political campaigns. Hashtags associated with climate concern show polarized viewpoints (Table-1). While the hashtag #PlasticFreePlanet emerged as the most frequently used hashtag in tweets with keyword 'Plastic', there are also hashtags that emphasize on the importance of taking ownership for fighting against plastic pollution. Beyond this basic description, the most frequently used hashtags were related to the following categories: -

**Hashtags associated with political campaigns**- the most frequently used hashtags from this category were #PlasticFreePlanet, #EarthDay2024, #SayNoToPlastic, #SwachhBharat, #PlasticPollution, #NarendraModi, #MannKiBaat and #SwachhBharatMission. Unlike discussion surrounding adoption of energy efficiency measures, plastic pollution has surged out of green bubble, capturing political attention at no less than G7 summit and United Nations. The issue of plastic pollution and the idea of plastic free planet became politicized as a result of many political announcements in this regard. Indian Government's campaign against plastic sought to create awareness against the usage of single use plastic and resolve the problem of plastic waste generation.

| Sr. No. | Hashtags | No. of Tweets |
|---|---|---|
| 1 | #PlasticFreePlanet | 8800 |
| 2 | #EarthDay2024 | 6546 |
| 3 | #SayNoToPlastic | 6540 |
| 4 | #SwachhBharat | 6410 |
| 5 | #PlasticPollution | 6090 |
| 6 | #NarendraModi | 5256 |
| 7 | #MannKiBaat | 3443 |
| 8 | #SwachhBharatMission | 3292 |

**Table-1 Most frequently used hashtags**

It was not about putting a blanket ban on single use plastic but creating awareness about the negative effects of plastic usage and launching a public movement to curb its use. Also, it aimed to phase out single use plastics by 2022. It provided a simple interpretation of the issues pertaining to plastic pollution placing emphasis on the role of public awareness in promoting action to address the issue. The results show that discourse surrounding plastic free planet on Twitter/X co-occurs with repeated mention of another nation-wide campaign Swachh Bharat that aims to create awareness about the importance of maintaining cleanliness and eliminating open defecation.

| Sr. No. | Hashtags | No. of Tweets |
|---|---|---|
| 1 | #PlasticFreePlanet | 8800 |
| 2 | #SayNoToPlastic | 6540 |
| 3 | #SwachhBharat | 6410 |
| 4 | #NarendraModi | 5256 |

| | | |
|---|---|---|
| 5 | #MannKiBaat | 3443 |
| 6 | #SwachhBharatMission | 3292 |

**Table-2 Hashtags Associated with Political Campaigns**

Many tweets posted and shared by people contained #NarendraModi along with responses towards government's decision to launch crack down on single use plastic and announcements on national and international platforms.

**Hashtags related to climate concerns-** the two most prominent aspects of climate concerns expressed in context of plastic pollution recognizable by hashtags were waste management and usage of single use plastic. It shows how people evaluate potential threats of plastic use. People expressed high level of concern about plastic pollution caused by usage of single use plastic, labelling plogging and proper plastic waste management as a solution.

| Sr. No. | Hashtags | No. of Tweets |
|---|---|---|
| 1 | #EarthDay2024 | 6546 |
| 2 | #SayNoToPlastic | 6540 |
| 3 | #PlasticPollution | 6090 |
| 4 | #WasteManagement | 3100 |
| 5 | #Plogging | 2534 |
| 6 | #ClimateCrisis | 1407 |
| 7 | #BanSingleUsePlastic | 1240 |

**Table-3 Hashtags Associated with Climate Concern**

**Hashtags related to societal responsibility**- Results show some frequently occurring hashtags in the Twitter/X data that project environmental protection as a societal responsibility, translating it from political announcements and complicated scientific reports into consideration of its impact on human lives. The most frequently mentioned hashtag in this category was #MyEnvironmentMyConcern reflecting a framing of environmental issues around realization of self-responsibility towards environment. The hashtag #SaveEarth is the 2nd most frequently occurring hashtag that belongs to this category where people expressed their opinion about responsibility as citizens to fight against and prevent climate change. The hashtag #WeAreTheFuture is 3rd most frequently repeated hashtag from this category followed by #SwachhataHiSeva and #MyCleanIndia. Most of the tweets containing above mentioned hashtags emphasize on grassroots movement, by individuals in every community and city across the nation.

| Sr. No. | Hashtags | No. of Tweets |
|---|---|---|
| 1 | #MyEnvironmentMyConcern | 937 |
| 2 | #SaveEarth | 840 |
| 3 | #WeAreTheFuture | 453 |
| 4 | #SwachhataHiSeva | 413 |
| 5 | #MyCleanIndia | 385 |

**Table-4 Hashtags Associated with Societal Responsibility**

It means taking ownership of their actions and responsibility for their part in the solution of this issue. Societal responsibility towards climate change cannot be fulfilled by passively watching the world leaders gathering every few months to discuss the possible solutions only to sit back and scrutinize their decisions.

**Discussion**

Since plastic pollution and idea of making this world plastic free, have a direct impact on everyday lives of the people it is quite understandable that they have a sentimental component to them. In the present research, a Twitter/X analysis was performed, and it was found that Earth Day theme of 2024, 'Planet vs. Plastics,' brought plastic pollution to the forefront of conversations. Throughout Earth Month, people responded with heightened awareness, support for positive initiatives and community-led discourse on Twitter/X. This growing understanding shows a great shift in public perception, plastic is no longer seen as just a convenience but as a long-term threat to ecosystem and human health. Sentiment analysis was carried out in the present research by using an advanced lexicon-based approach. Tweets with keyword 'Plastic' were subdivided on the basis of their positive, negative and neutral connotations. These sentiments irrespective of their character play an important role in how people respond to different issues and interact with other members in their surroundings.

Figure 3 shows a word cloud that incorporates all the words that contributed most to the expression of sentiments towards plastic. Net sentiment score is -31.6%. The reason for negative net sentiment score is that positive words have been used less and negative words have been used more when discussing the issue of plastic pollution. The word "waste" contributes most to the discussion. Plastic pollution does not emerge as positive subject of discussion and tweets don't reflect happiness about it. Figure-5 shows that people use words like "burden", "harmful", or a "threat" while discussing about plastic pollution. More usage of such negative words leads to the drop in positive sentiments score. Different negative words like "pollution", "waste", "dangerous", and "crisis" have been used more frequently in tweets, adding to the decrease in positive score. It shows the growing anger in India against Plastic and various concerns being raised by people. The words "waste management" and "cleanliness" have been used relatively more frequently in these tweets. Another important observation emphasizing the positive aspect is that we see the usage of relatively very less profanity when discussing about plastic. Figure-5 shows that action-oriented words "cooperate" "support" "cleanliness" "visionary" "better" are also used more in the tweets pertaining to plastic. This indicates that people are willing to spread awareness and support initiatives or campaigns against plastic. Another important observation is that people respond differently to climatological changes pertaining to plastic pollution that they are encountering in everyday lives. The public response to information surrounding plastic is directly influenced by these climatological changes. The results prove that sentiment analysis tools can be used to study how the public feels about an issue. However, the restrictive nature of tweets and algorithms make it difficult to understand how a particular aspect is to be assessed. In the present study, the sentiment analysis showed that net sentiment value of tweets containing keyword 'Plastic' is negative. however, it does not indicate dominance of negative sentiments towards the ides of plastic free planet. The negative value of net sentiment, which can be considered as an expression of individual like or dislike towards or against an issue at the time the tweet was created, denotes that people may have negative sentiments towards the problems associated with plastic pollution.

"What we see emerging … is not simply a fragmented society composed of isolated individuals, but instead a patchwork of overlapping public spheres centred around specific themes and communities which

through their overlap nonetheless form a network of issue publics that is able to act as an effective substitute for the conventional, universal public sphere of the mass media age." (Bruns, 2008)

The analysis of frequently used hashtags allows us to understand the concept of 'issue publics' as mentioned by Bruns in above cited summary. We can identify emerging publics who are more concerned about plastic pollution and climate change issues. Whereas hashtags like #MannKiBaat, #NarendraModi, #SwachhBharat help us in identifying pre-existing publics focussed on different issues and motives that go beyond climate change. The usage of these hashtags in conjunction with the term 'Plastic' provided an area of overlap. This overlap may take the form of using plastic pollution and climate change issues to increase the reach of political campaigns and messages. The hashtags that specify climate concerns and societal responsibility help us in understanding how publics can emerge without any association with environmental NGOs.

## CONCLUSION

The present research provides an analysis of public discourse regarding plastic use and the broader aspiration of eliminating plastic from our environment. Sentiments and Words uncovered by the present research analysis suggest that most of the responses are from climate change believers rather than deniers. Results suggest that Twitter/X is an important resource for creation of public discourse around climate change issues. The results show that tweets containing the word "pollution" and "waste" are more negative than all tweets. The words that appear in tweets indicate that Twitter/X sphere is predominated by climate change believers and complies with scientific consensus on climate change. Frequent usage of words "cooperate" and "support" in collected tweets also helps in strengthening the findings. The decreased denial of climate change is evident in tweets and shows how democratization in information sharing through Twitter/X may circumvent the negative influence of climate change deniers on public sentiments. The results show that conversation on Twitter/X about consequences of plastic pollution bear negative sentiment value due to an increased usage of words such as "threat", "crisis", and "harm". It suggests that Twitter/X can be a valuable source for social science researchers and policy makers in the ongoing fight against anthropogenic climate change.

This research shows that hashtags associated with political campaigns were most frequently used in public discourse about plastic. The results suggest that there is politicization of plastic pollution and other climate change issues in India. Tweets with keyword 'Plastic' also contained hashtags that associate climate change issues with societal responsibility towards environment. Therefore, the usage of such hashtags represented efforts to connect publics with particular interests with debate about climate change.

### Limitations

The collected textual data from Twitter/X was fairly adequate and the outcomes were also quite accurate when compared with real world scenario. But notwithstanding the number of tweets collected was still very limited. It happened on account of complex screening and introduction of geotag filtration parameter. A larger set of tweets with richer data would have generated superior outcomes.

Quality of Twitter/X data could have been better. Despite the proper screening and filtration, there were some tweets which led to zero score from sentiment analyser, implying that those tweets don't express any sentiment towards plastic use and the idea of plastic free planet. Large number of expressive tweets along with lesser number of no sentiment tweets would have yielded more diverse and meaningful results.

**Future Work**

Further changes and work strategy would involve introduction of more syntactic relations along with better NLP filtering. Sentiment analyser lexicon for custom words could be used which will contain scores for custom words. An improved and more advanced comparison approach can be taken such as clustering. A repetition of research could be carried out with more keywords to get a better set of tweets for better results.

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