Investigation of the Plastic Straw and Collection of policy feedback via mass media analysis utilizing Generative Pre-trained Transformers

Abstract

Humanity has entered a new age when it comes to administration. Information is faster than ever and it is evident that the government will never be quick enough in their responses to disasters. Hurricane Katrina, Chernobyl, Covid-19 were all disasters that accentuated the tardiness of our modern government systems. Rarely those administrative bodies would get criticized for early action. However, the recent discourse of the plastic straw ban and its outcomes may be an indication that a hasty response does more harm than good.

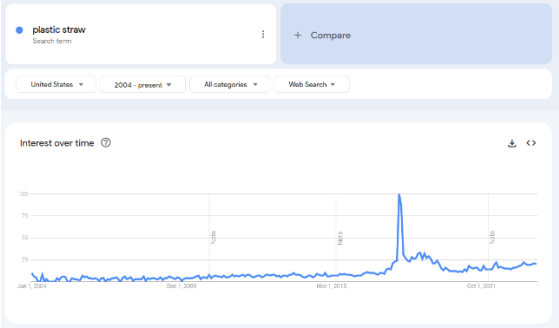
Introduction

There exist potential drawbacks of our current disaster response model and the semantic aspect of these policies must be quantified. But because the internet has not been utilized until a few decades ago, we have limited study and data on how our governments can utilize this new tool for surveillance. Additionally, the data provided had to be processed manually, inducing a high labor cost to analyze even a small portion of opinions. However, the advent of Generative Pre-trained Transformers greatly alleviates this problem, and has enabled numerous academic fields to process insurmountable texts for a fraction of manual labor cost.

The plastic straw discussion has emerged in 2018 and rapidly spread throughout social media, and became the focal point of public discourse. The plastic straw ban policy satisfies multiple criteria needed for this study.

- It is straightforward to narrate and understand the problem of plastic straws
- Plastic straws are ubiquitous and most of the population use it for day-to-day life
- The event happened after the introduction of the internet and thus has been well documented.
- The event happened at well-known point in time, specifically early 2018[1]
- The social panic induced by the attention to plastic straws links to plastic pollution, a major and ongoing environmental issue

[1] This can be attributed to the fact that plastic straws are not commonly searched and do not have much overlap between potential other unrelated trends. For example, the search for trees may be related to forest fires or skill/technical trees in game language.



Google trends figure for searching plastic straw. Taken Dec 2023. Interest has peaked on July 2018. Fair use

By investigating the scientific background of plastic and paper straws, statistical significance of their harm to the ecosystem, the temporal fluctuation of public reaction, and responses from governments and companies, we can gain insight on what an effective treatment to social panic.

To achieve an unbiased, accurate understanding of the material, many of the factual statements regarding paper and plastic straws have been concluded from reputable and authoritative sources such as academic journals and medical guidelines.[2]

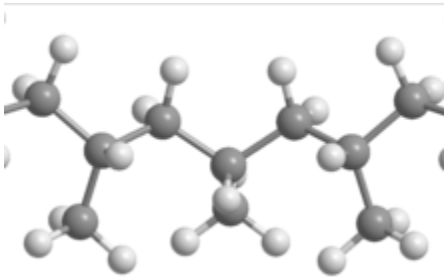
The research involves the incorporation of a free search engine DuckDuckGo for searching relevant content online, Puppeteer (automated Chrome browser controller) for navigation and text content, Generative Pre-trained Transformer (GPT) for topic categorization and semantic analysis, and matplotlib for visual inspection.

Utilizing these tools can help us understand the flow and trends of information and opinions, ultimately guiding us to create better policies at the right time.

[2] It has become evident that many news outlets and bloggers do not interpret primary sources cited by the original article, thus causing a "telephone game" of misleading information. Careful evaluation of every source and their citations have been performed as a preventative measure against this malpractice.

Scientific background of plastic straws and plastic pollution

Most plastic straws are made from a type of plastic called polypropylene (PP).



Polypropylene molecule chain, Wikipedia commons

The molecular composition is (C3H6)n, meaning it is solely composed of carbon and hydrogen atoms.

Many paper straws use polyfluoroalkyl substances, otherwise known as PFAs or colloquially: “forever chemicals”.

PFAs skeletal structure, Wikipedia commons

The structure contains additional Florine atoms for creating a non-reactive, slippery, waterproof surface found inside many paper straws, 90% of them found in one study (Assessment of poly- and perfluoroalkyl substances). PFAs are under heavy research as it has been showing to influence many parts of biological processes

Plastic straws account for 4% of all plastic trash by count, and 0.025% by weight (Science Says: Amount of straws, plastic pollution is huge). 90% of all plastic pollution originate from top 10 rivers in the world (Environ. Sci. Technol. 2017). PP has lower ultra-violet radiation (UV) resistance than PFAs (Examining the UV resistance qualities of polypropylene and nylon).

Metal straws, commonly referred to as the ideal replacement for plastic straws, have a higher carbon footprint due to the energy it takes to process metal, not to mention the water it takes to wash the straw. This is a rather common theme with a lot of replacement items[3]. Realistically, the majority of metal straw users will never offset the carbon footprint of plastic straws.

Paper straws cannot be recycled. The production of pulp is an environmentally taxing process, as it requires cellulose from trees. Additionally, many paper straws cannot be practical without PFAs, as they will lose their structural integrity for even mild use cases.

Case study: Pubic reception of the plastic straw and its ban

A YouTube video titled “Sea Turtle with Straw up its Nostril - "NO" TO SINGLE-USE PLASTIC”, uploaded in Aug 10, 2015, films a marine biologist pulling a straw out of a sea turtle’s nostril[4]. Later this

[3] Organic cotton totes have to be reused over 20,000 times, metal straws 150 times, paper bags 8 times.
[4] According to statistics, the video has 110 million views, 771K likes, and 54K dislikes (estimate), resulting in a 93.5% like rate

video would gain massive public attention and would be regarded as the trigger for many environmental activists.

Many environmental advocate groups have protested throughout 2016 and 2018. The tag #stopsucking, referring to sucking on plastic straws, trended in Twitter (X, as of 2023) among celebrities. Many people have ignored this outcry because conflict and movements in Twitter have been mostly temporary and do not warrant real life actions.

In July 2018, Seattle became the first metropolitan to issue a ban on plastic straws[5]. Many municipalities in California[6], New Jersey[7], Florida[8], and other states would shortly follow (Plastic straws why). Companies such as Starbucks[9] and McDonalds[10] also followed suite by adapting policies to replace or eliminate plastic straws, by providing plastic lids and paper straws. However, many have pointed out the hypocrisy[11] of these restaurants and companies as they would evidently lack the effort to reduce plastic waste in other areas. This would be dubbed "slacktivism[12]"

These policies have been perceived by the people as a type of Greenwashing[13] and would soon gain negative traction. In September 4, 2020, then U.S President Donald Trump would rant about plastic straws. Despite the interview clip being labeled as "bizarre", many commenters have scrutinized The Independent

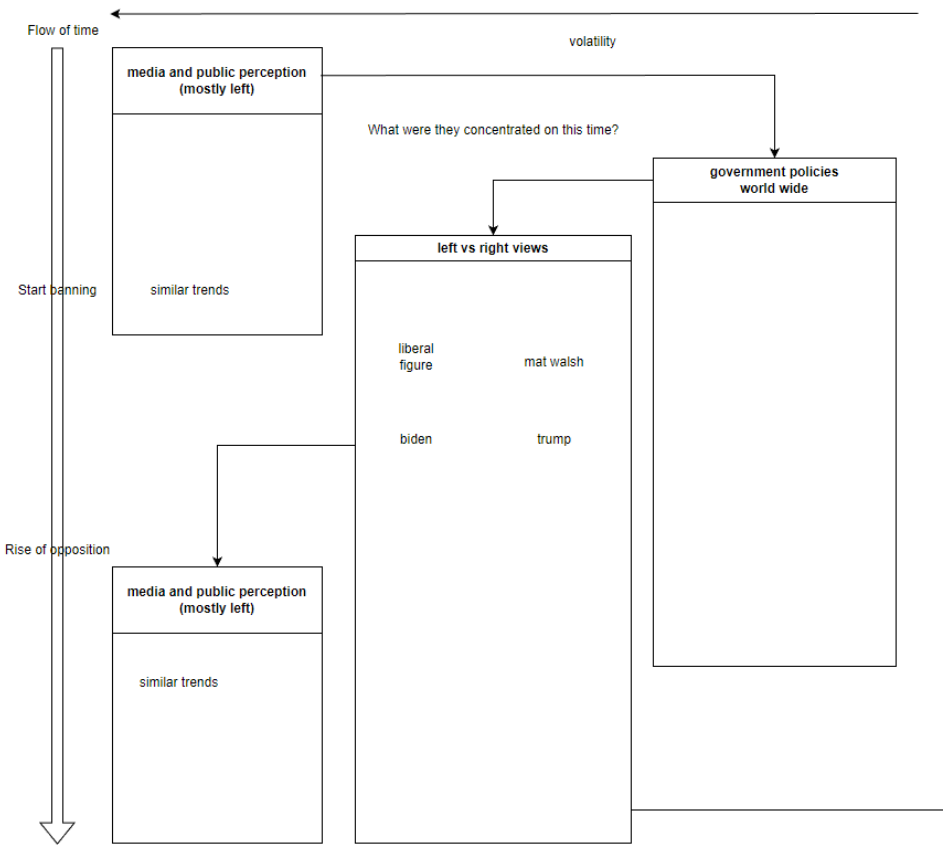
[5] Food service businesses are no longer able to provide plastic straws and utensils — including forks, spoons, knives, and cocktail picks. Instead, on request, they may provide approved compostable alternatives for dine-in service, and compostable or recyclable take-out packaging. Flexible plastic straws can be provided to customers who need a straw because of medical reasons.
[6] unless a customer specifically makes a request to be provided with a straw, full-service restaurants are prohibited from automatically providing single-use plastic straws with beverages
[7] no store or food service business shall provide or sell a single-use plastic carryout bag to a customer; no grocery store shall provide or sell a single-use paper carryout bag to a customer.
[8] Plastic carryout bags and straws prohibited. * Upon request, a food service business may provide a single-use plastic straw to a person who requires a single-use plastic straw due to a disability or medical condition.
[9] Provided sippy cups instead of straws.
[10] Have started to provide plastic lids in some regions. A global ban has still not passed the decision of shareholders as of Dec 2023.
[11] For example, Starbucks's sippy cups are still made out of PP and use more plastic. These lids reached an alleged 3% recycle rate.
[12] The practice of supporting a political or social cause by means such as social media or online petitions, characterized as involving very little effort or commitment. (Wikipedia)
[13] a form of advertising or marketing spin in which green PR and green marketing are deceptively used to persuade the public that an organization's products, aims, and policies are environmentally friendly

for accusing the speech of being “bizarre” when they are “facts”. These negative sentiments ranged greatly from blind hate speech to constructive criticism. As of December 2023, this negative sentiment is reaching its peak and have sparked numerous online discussions. In August 2023, Matt Walsh, a popular right wing public figure, has released a video titled “Plastic Straws Confirmed To Be Worse Than Plastic Straws”. Despite many flaws in his argument[14] in the video, it is evident that many people have resonated with him, as the video would result in 686K views and a 97.8% like rate, higher than many other anti-plastic straw videos[15]. While it is true that this is far from a valid measurement from a general public sentiment, as YouTube as a platform is an entertainment source than a surveying tool, the high view count and like rate is an undeniable indicator that there exists a great population that actively dissents the proliferation of these anti-plastic straw rhetoric.

Information propagation theory

Based on superficial observations, one can notice that negative sentiment has followed after the positive sentiment for the anti-plastic straw argument. These sentiments may offer some qualitative insight to law makers and political figures, but it is hard to justify the conclusions when interpretation is highly subjective.

[14] He has failed to recognize that the same study also measured PFAs from plastic straws, which 60% of them did, compared to 90% in paper straws.
[15] Straw No More (TED talk), Oct 2017, 287K views: 90%, Gutfeld on plastic straw ban in California, Jul 25, 163K views, 92.4%



Conceptual diagram of influencing bodies

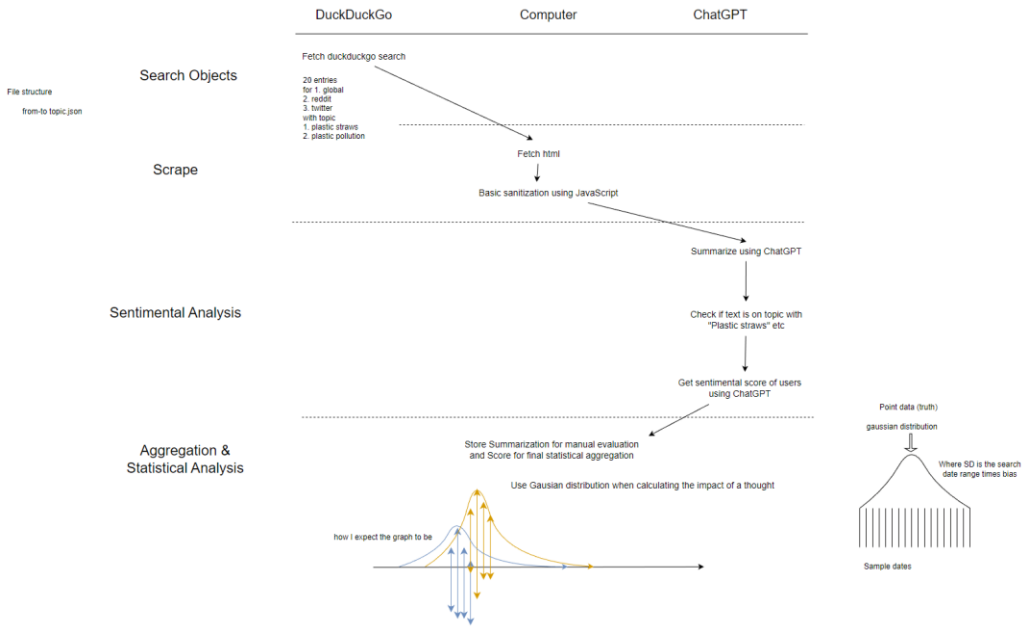
Information propagation theory attempts to describe the relationship between positive and negative sentiment of a given topic. The foundational philosophy lies on the fact that many are eager to dismiss conversations until an action is taken. Thus, the conservative response will lag behind progressive movements. Surveying a large population is a great way to measure this, but takes a lot of time and resources to do so, and these can often be heavily biased depending on demographic, whether intentional or not.

It is possible to mathematically evaluate the delay by treating responses as waves. Using two demographics sentiment change over time, characteristics about the wave and propagation can be quantitatively measured. These characteristics can then be used to estimate the effects of a policy and prompt reforms.

Quantitative research plan

The abundance of information becomes a barrier when it comes to analysis as one is able to achieve a plethora of arguments for both sides with no apparent exhaustive summaries. To gain quantitative data from the internet, multiple strategies have been specifically devised and developed.

The data processing pipeline consists of four stages. Entity search phase, data collection phase, topic filtering and sentimental analysis phase, and aggregation and statistical analysis stage.



Visual of the data processing pipeline

The search phase utilizes the lesser-known DuckDuckGo search engine over Google. This choice was to prevent the introduction of any bias Google might display in the search results to the referred sites. The search scope has been set from the start of 2015 to end of 2023, including 3 years of headroom before interest have peaked in mid-2018. The search period was split into 182 day (half a year) intervals and for each interval 20 top queries have been collected, and this has been performed using a general search and site specific search for reddit and twitter. During this stage, however, the exact date of the posting is lost,

due to there not being a reliable way of extracting this information. In total, the search process resulted in approximately 60 queries or exactly 1218 site results in total.

The data collection phase incorporates an automated Chrome browsing program named Puppeteer. For each of the sites, the browser would visit and wait for all content to load, and then extract the text content using a standard way, similar to how screen readers work. This content would then be stripped of certain characters and go through lightweight text processing to make manual review and inspection easier. This process has taken approximately 5 hours to browse all 1218 sites. Some sites have refused to load the content or even caused the program to crash. These have been marked as ignored and would not be processed. There were 1210 valid instances of readable text content.

The sentimental analysis phase leverages an affordable GPT (will be referred to as agent) API solution provided by OpenAI[16]. For each text content, the agent has been asked to summarize the content of text in order to decrease the amount of information passed to subsequent agents. Then, another agent is asked to identify whether the text is referring to plastic pollution or plastic straws. If yes, another sentimental analysis agent describes their thoughts by giving a conclusion summary of the material, and gives a score from -1.0 to 1.0, with 1.0 being in agreement of banning plastic straws. This process took about 2 hours and 3,300 queries to OpenAI. The agents have consumed roughly 3 million words for analysis. The total cost has been $4.56. At the end of this process, 801 valid on-topic sentiments have been collected.

The aggregation stage creates a virtual plot to lay out the sentiment change over time. The positive and negative sentiment calculation follows the following formula:

$$p = (1 + s) \cdot e$$

$$n = (s - 1) \cdot e$$

[16] Specifically, gpt-3.5-turbo-1106 has been used

Where p and n are positive and negative sentiment scores, s is the raw sentiment value, and e is the effect factor. The effect factor is determined by a Gaussian distribution formula.[17]

$$x = mid(start, end)$$

$$SD = (end - start) \cdot B$$

$$e = G(x, d, SD)$$

Where the plot date is the evaluation point, the origin point, x, is determined by the bisection point of query search start and end date, and standard deviation, SD, by the width of the interval times a bias, B, which helps with visualization later. The data has been sampled from start of 2015 to end of 2023, with 1 month intervals. The sentiments have been summed in a linear manner. When plotting, per-site bias has been applied to help visualize the information. These were linear biases and the values were

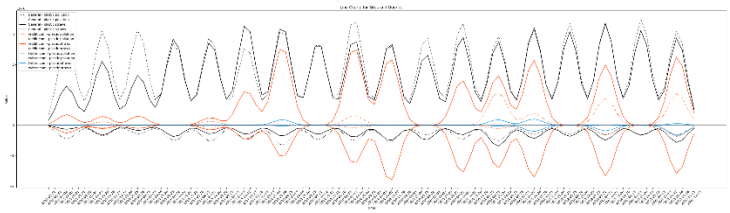
type	Plastic straw	Plastic pollution
Reddit	2	6
Twitter	18	43
General search*	**1**	**1**

Non-biased versions of the graph were made available in the research repository. These line graphs were then rendered using Python and matplotlib. Solid lines represent interest in plastic straws while dotted lines represent interest in plastic pollution. Lines above 0 represent positive sentiment towards the plastic straw ban while lines below zero represent negative sentiment.

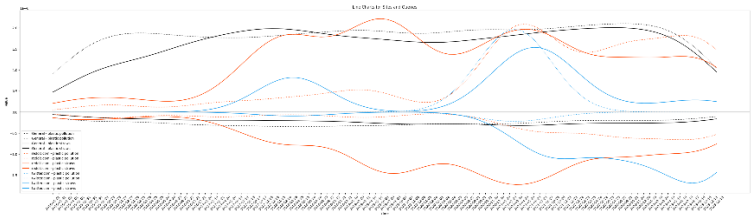
17 $\frac{1}{\sigma\sqrt{2\pi}} \cdot \exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right)$

Data interpretation

Before analyzing the data, it is imperative to be aware of the shortcomings of the graphical analysis. Firstly, the rather high standard deviation bias and a broad interval of 6 months have caused tail end values, values close to early 2015 or late 2023, see artificial decline in data values. Lowering the standard deviation bias alleviates this issue, but makes interpreting the graph harder. The solution would to have higher query resolution. However, as of Dec 2023, DuckDuckGo does not allow such massive queries to be performed.



Graph when standard deviation bias is 0.5[18]

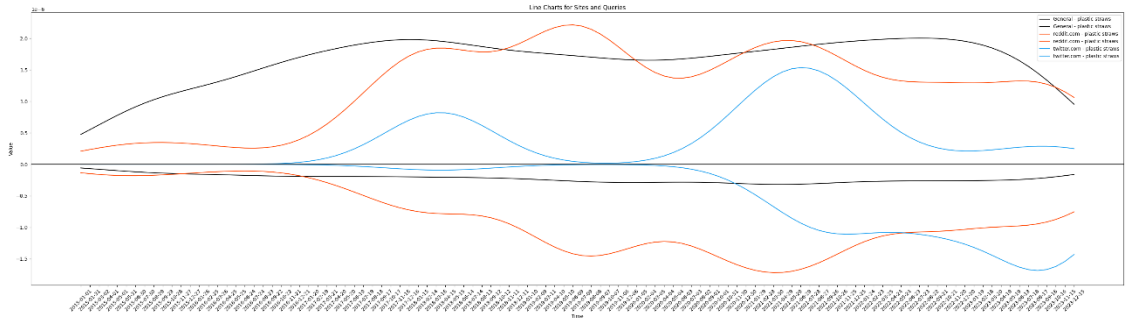


Graph when standard deviation bias is 2

Therefore, the tail ends of the graphs have to be interpreted with an expected value decrease in mind that is not due to real data.

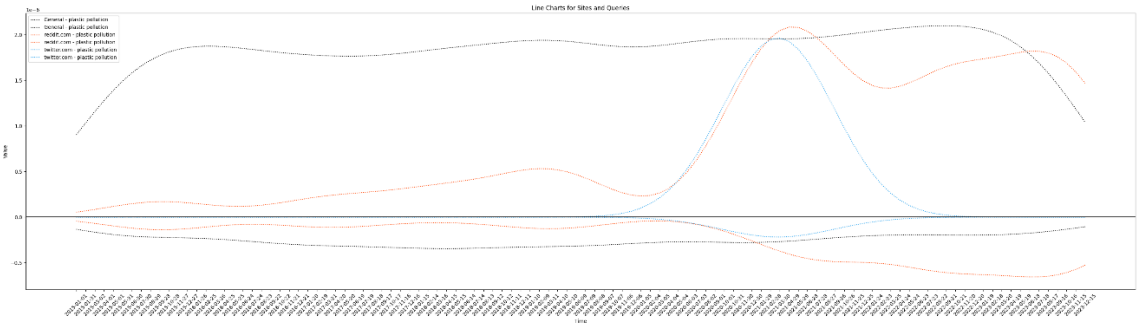
Additionally, Twitter has been selective with the content the automated browsing environment can visit[19]. It has later been determined that the effect is negligible as this seemingly happens at random intervals, but Twitter data is fundamentally unreliable and should only be used for insight.

[18] Not published
[19] You are required to have an account to view content on some cases



Plastic straw sentiment, normalized, 2015~2023

The graphs present a general public interest hike starting from 2015, and Reddit started to discuss about the topic earlier than Twitter. Interest towards plastic straws have increased mid-2017, and have subsequently decreased late 2018. Reddit saw a similar decrease but rebounded during 2019, and saw an average decrease in sentiment. Later on, Twitter would see a second interest increase during 2020, but while positive sentiment quickly decreased in 2 years, negative sentiment would continue to grow to an almost perfect negative sentiment towards late 2023. In this time Reddit saw an overall decrease in engagement. During this time, the general argument has mostly been positive towards the anti-plastic straw argument, only introducing mild negative sentiment starting from 2018.



Plastic pollution sentiment, normalized, 2015~2023

In discussions surrounding plastic pollution, the sentiment towards banning plastic straws have increased rapidly during early 2021. However, subsequent sentiment has been negative, embodying mostly the thought that plastic straws are not the problem. The general public interest has not changed in a meaningful way during this period

Limitations of the study

Unfortunately, there were difficulties in devising a mathematical formula for these interest patterns. The turbulence in data due to sparse query resolution have been proven to be a determinantal factor for the graph quality. Future studies should incorporate a larger data sample (more than 1200) and have better timespan resolution to avoid this issue. Additionally, a series of localized studies for each of the bills passed will greatly improve the clarify of information propagation.

The narrow nature of this topic requires careful acknowledgements before generalizing to other political topics. The plastic straw ban might be a severe outlier in terms of political events. Other highly debated topics have to be analyzed with this method in order for it to be generalized to future policies and be practical.

Conclusion

As indicated by the graph, a greatly negative sentiment has formed shortly after policies were set. These negative sentiments harm the credibility and trust of people, and weakens the influence of future policies. It also visually confirms a 1-year retention rate of attention to specific issues. Policy makers can utilize this analysis method to identify demographics and specifically reach out in a case-by-case basis to minimize negative sentiment. While the research is not a definitive proof that the anti-plastic straw policies

have been enacted too early, there are many indicators that the early action have caused many people to lose trust towards government and corporates. This incident provides valuable lessons on how our government should handle disasters and social panic.

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