Public Perceptions on Climate Change:
A Sentiment Analysis Approach

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ABSTRACT

Public perception on climate change is a paramount component that affects the implementation of adaptation and mitigation measures. Taking into account the public perceptions on the issue may assist decision-makers in producing appropriate strategies to ameliorate the impacts of climate change. A corpus-driven sentiment analysis approach was done to classify the polarity of Malaysian public perceptions, identify the sentiment lexicon, and analyse the public sentiments. A part of a specialised corpus namely the Malaysian Diachronic Climate Change Corpus (MyDCCC) was developed from The Sun Daily and was used as the data for this study. The methodology involved the employment of Azure Machine Learning software to conduct sentiment analysis to explore the polarity of public sentiments, corpus analysis approach to identify the sentiment lexicon and discourse analysis to analyse public sentiments based on the identified sentiment lexicon. The results revealed that the majority of public sentiments appeared to be negative, depicting sentiment words such as *long, critical,* and *serious.* Positive sentiment words also prevailed such as *better, best* and *hope.* The discourse analysis revealed that the public is reasonably insightful of climate change although their sentiments appeared to be negative. However, the negative stance was largely influenced by the public's indignation with how decision-makers handle the climate change issue. Ironically, the negative sentiments may be an indication for the decision-makers to improve their approach in addressing climate

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change. This study has contributed significantly to research on public perceptions of climate change in the Malaysian context.

INTRODUCTION

Climate change is a very concerning issue that has been talked about for decades. It is now affecting the globe even worse than before. This situation is evident by various phenomena that are currently happening in the world. The United Nations Framework Convention on Climate Change (UNFCC) (2011) refers to climate change as any changes towards climate caused by human activity that alters the compositions of the global atmosphere. The Intergovernmental Panel on Climate Change (IPCC) (2007) which was established in November 1988 released the first report that highlighted concerns about emissions resulting from human activities, that substantially increased the atmospheric concentration of greenhouse gases. As a result, the World Global Climate Conference for a global treaty was held, and since then various conferences on climate change have been conducted, and policies were developed to address the issue of climate change. The most notable one is the Paris Agreement. The implementation of the Paris Agreement is paramount for the achievement of the Sustainable Development Goals (SDGs). The Sustainable Development Goals (SDGs) or Global Goals that were adopted by all UN Member States in 2015 is also one of the plans and actions to end poverty, protect the planet and improve the lives and prospects of everyone and everywhere by 2030 (United Nations, n.d).

Recent disasters due to climate change have also been reported in the media. Tandon (2021), for instance, claims that Jakarta is facing climate change issues and is predicted to be the fastest sinking city in the world, with North Jakarta expected to be submerged underwater by up to 95% by the end of 2050. Canada was also recently scorched by an infernal summer in the westernmost province of British Columbia in June 2021, smashing national temperature records and contributing to more than 500 deaths. It also heralded the start of the province's third-worst wildfire season (Williams, 2021). The same soaring temperature phenomenon hit Turkey as the country witnessed an unprecedented surge in forest fires which started at the end of July 2021 and took two weeks to put out. The 240 wildfires killed at least eight people and devastated villages as well as claiming the lives of a large number of animals (Daily Sabah, 2021). United Kingdom's 2021 summer was in the top 10 hottest weather ever recorded, ranking 9th and being about 1 degree Celsius warmer than average (Carrington, 2021). Carrington (2021) also adds the accelerating impacts of climate change have affected the devastating wildfires in Europe, Russia, and the United States, creating a record-breaking heatwave in north-western North America, as well as extreme and deadly floods in Germany and China.

STATEMENT OF THE PROBLEM

Numerous steps have been taken to mitigate climate change. Where mitigation plan on the global level is concerned, one of the biggest and highest mitigation plan that is currently exercised by most countries in the world is through the Paris Agreement. According to the United Nations (2021), Paris Agreement is a legally binding international treaty on climate change and is currently adopted by 191 parties or countries from all around the world. In Malaysia, mitigation plan such as the Green Technology Masterplan 2017-2030 has been established in 2010 with the mandate to spearhead the development and promotion of green

technology as a strategic engine of socioeconomic growth (Malaysian Green Technology and Climate Change Centre, 2019). The framework is primarily used by local authorities to guide the transformation of cities which are under their jurisdiction into low carbon cities.

Though there are numerous steps taken to mitigate climate change, the implementation of these steps depends on the public opinion towards the issue (Dahal et al., 2019). Public perception on climate change acts as an important element that affects attitudes towards the adaptation and mitigation on climate change issues. An understanding of public perception may assist decision-makers or policy-makers to produce appropriate adaptation and mitigation strategies to improve the condition of the earth. Several studies examine public perceptions towards climate change on several issues (Pisasrski et al. 2013; Voskaki et al. 2015; Lorencová et al. 2019; Brooks et al. 2020, Yu et al. 2021). Pisasrski et al. (2013) examine public attitudes and reactions to energy technology that may mitigate climate change through a citizen round table process, and states that the public's understanding about climate change and the mitigation approach increased strongly when the public is given extensive insights about the issue and plan, though some of the participants had no particular interest nor knowledge about the energy technology mitigation approach.

Brooks et al., (2021) explore public opinion towards a climate change mitigation approach on warning labels on gas pumps. The study claim that warning labels may activate extant climate concern norms and shift public opinion toward long-term support of sustainable transportation emissions policies and practices. The labels also help to increase the self-efficacy beliefs of the public towards climate change issues. Yu et al., (2021) assess the public's water literacy awareness, attitudes and behaviours in Taiwan. The study state that the majority of the respondents attain a high level of water literacy and develop sufficient water-saving habits. However, the majority of the respondents were still relatively inactive in performing actions to ease the impact of climate change on water in refusing to buy products with "water proficiency labels", participating in stream-cleaning and water purification activities. This study depicts that the public perceptions about climate change remain relatively unsatisfactory though they do possess basic delineations of climate change. This calls for more research to be conducted about how the public perceives climate change.

Understanding the public perceptions on climate change is not mere research but a mandatory precondition in developing and conceiving mitigation and adaptation strategies towards climate change. Cvetković and Grbic (2021) examined public perception based on socio-demographic factors among the people in Serbia. They claim that there are insufficient investigations towards the knowledge of the processes, causes and consequences of the public perceptions. Where research on public perception on climate change within the Malaysian context is concerned, several studies described the level of climate literacy (Wan Nur Syamilah & Nasuha, 2021; Chea et al., 2021). However, these studies investigate such perceptions by analysing elements such as socio-demographic factors (Wan Nur Syamilah & Nasuha, 2021) and recycling awareness among Malaysians (Chea et al., 2021). Thus far, the researchers have not found any study in Malaysia that examine public perceptions on climate change through the linguistic or discourse perspective. The discourse in public perceptions is pertinent as it may reveal the real notion and underlying reasons behind the perceptions about climate change. By understanding the notions of the public perceptions on climate change, the respective parties such as the decision-makers could subtly find the right strategy to ameliorate the society's thoughts and behaviour, produce the proper mitigation and adaptation plans of climate change.

Public perceptions may be analysed through various approaches, including sentiment analysis, which is used in this study. Sentiment analysis is the process of identifying the emotions and opinions expressed in a particular text (Medhat et al., 2014). From the social science perspective, the term sentiment may also be adopted as the term for attitude and beliefs. Although several studies have utilised sentiment analysis in examining public perceptions on

climate change, the studies only described merely the polarity of the sentiments with regards to temporal and geospatial areas comparisons (Dahal et al., 2015), publication framings (Jiang et al., 2017). None is associated with the linguistics or discourse perspectives. While most sentiment analysis studies mainly use social media such as Twitter as their source of data (Pak and Paroubek, 2010; Agarwal et al., 2011; Qaisi et al., 2016; Sailunaz and Alhajj, 2019), newspaper article has diverse context length which makes it complex yet an interesting source to be analysed. Therefore, for this present study, newspaper has been selected as the data source, focusing on the editorial section of an online English Malaysian newspapers rather than report news since the editorial section involved opinion genre. Based on the literature review, the researchers managed to find one study that use newspaper in employing climate change sentiment analysis (Jiang et al., 2017). However, Jiang et al. (2017) study does not describe the linguistic or discourse features of the data, but rather merely comparing the publication framings throughout various locations. Therefore, this present study is timely because it can contribute to the scant literature on public perceptions on climate change in newspaper, using a sentiment analysis approach, specifically in the Malaysian context.

To explore further the public perceptions on climate change, the present study aimed to examine the polarity of the public sentiments through sentiment analysis, analyse the discourse context of the sentiments through discourse analysis while using a corpus-driven approach. Therefore, three research objectives were formulated. An online English Malaysian newspaper, The Sun Daily, was used as the source of data. As such, the research objectives are to:

1. Classify the polarity of the public sentiments about climate change issues.
2. Identify the words that comprised the sentiment lexicon in the news articles.
3. Discern the public sentiments on climate change based on the sentiment lexicon.

LITERATURE REVIEW

PUBLIC PERCEPTIONS AND CLIMATE CHANGE

Past studies have examined public perceptions on climate change (Xie et al., 2020; Yu et al, 2013; Shi et al., 2015, Voskaki et al., 2015, Lorencova et al, 2019, Yu et al., 2021) and its impact on increasing the risk of climate change (Reser et al., 2012; Anderson et al, 2018). Several studies conclude that the level of danger and seriousness of climate change issue differ from one group to another. Some people believe that climate change is a very serious issue that the world is dealing with, while others perceive it as a phenomenon that is not paramount (Capstick et al., 2013; Voskaki et al., 2015). Reser et al., (2012) state that people in Australia are aware of climate change but attain different stands and experiences in interacting with the issue. Reser et al. (2012) also claim that majority of the respondents believe that the world's climate is changing, 50% already experience the effects of climate change and more than half of the respondents indicate their immediate concern towards the issue. On the bright side, the same study indicates that a majority of the respondents opines that it is mandatory to take instant appropriate measures in mitigating climate change.

In addition to that, another study in Wales states that majority of the public believe that the phenomenon of climate change is real and is currently happening, whilst minority of the public states otherwise (Capstick et al., 2013). Capstick et al, (2013) indicate that 36% and 48% of the public are deeply concerned and relatively concerned about the issue, respectively. Unfortunately, though the number is low but rather makes an impact, 7% of the public still states that climate change is a phenomenon that should not be a concern at all. The same study also investigates the discernment of climate change causes among the public. A total of 52% of the public indicate that both natural processes and human activities are responsible for

climate change, 35% claims that human activities are the only cause of climate change, whilst 11% believe that climate change happens solely due to natural processes. This is also similar to another study in Britain that claims 48% of the public indicate that climate change is attributed to natural processes and human activities, 37% said it is caused only by human activities, whilst 12% affirms that it is merely the nature's responsibility (Capstick et al., 2015). The same study also states that majority of the public are deeply concerned about climate change and believe that the climate is currently changing.

The differences in public's beliefs and stands in climate change phenomenon are said to be influenced by various factors. In some studies, public perceptions on climate change are found to be influenced by a person's level of education, awareness and knowledge (Drummond & Fischkoff, 2017; Leiserowitz, 2007). Education level is one of the major factors associated with the awareness of climate change (Knight, 2016; Monroe et al., 2019, Owusu et al., 2019; Cvetković and Grbic, 2021). A study by Cvetković and Grbic (2021) claim that individuals with a higher education level tend to have a higher awareness of climate change threats. Certain studies claim that socio-demographic factors such as gender, age, employment status and marital status play roles in how people perceive climate change (Shi et al., 2015; Yu et al., 2013; Cvetković & Grbic, 2021). As such, several studies claim that women are most connected to climate change as compared to men (Hornsey et al, 2016; Macias, 2016). However, this is in contrast with Cvetković and Grbic (2021) who indicate that gender has no relation with climate change perceptions level. On the other hand, Cvetković and Grbic (2021) affirm that married individuals are more vulnerable towards climate change impacts than those who are not married. In addition to that, employment status affects the vulnerability of an individual towards climate change and age affects the perception level of individuals in climate change.

Although the influence of public perceptions towards climate change may vary from one individual to another, the actions that are willing to be taken upon the issue is paramount. Mitigation and adaptation measures can make an impact in resolving climate change issues even with the smallest steps. Li et al. (2017) explore the complex relationships between climate change perception and actual adaptation behaviour in Hungary. The results reveal that no consistent evidence that beliefs in climate change risks may lead to the actual adaptation behaviour. Instead, belief in climate change risk is caused by the awareness of extreme weather events and water shortage. However, the actual climate change adaptation behaviour made by the farmers in the study is only due to the awareness of extreme events that were experienced by them. Another study by Ricart et al. (2019) that examine the beliefs and attitudes towards climate change among farmers and the public revealed that the greater the years of farmers' farming experience, the greater the level of climate change awareness is being attained. However, this is contrary to the public in the study in which climate change issues tend to instil the feeling of fatigue to older generations, whilst giving more consciousness to the younger generations and helping them to drive adaptation measures.

METHODOLOGY

This study employed both quantitative and qualitative methods. One of the quantitative methods involved a sentiment analysis approach using a software called Azure Machine Learning to explore the polarity of the public sentiments on climate change. Another quantitative method involved a corpus-driven approach using AntConc 3.5.9 as well as Microsoft Excel 2019 to identify the sentiment lexicon in the news articles. The qualitative analysis involved discourse analysis which was assisted through concordance tool in AntConc 3.5.9, to discern the public sentiments on climate change based on the sentiment lexicon found. A detailed explanation of the methodology is in the section that follows.

THE CORPUS

A corpus is defined as "*a collection of natural texts compiled from written or spoken speech or writings, constructed for specific purposes, and is stored in digital format*" (Imran et al., 2021, p. 67). A corpus-driven approach was employed as it is a structured way to compare language across large datasets. The corpus driven-approach is a "*a methodology where the corpus acts as an empirical basis in which the researcher extracts data and analyse patterns without any expectations or assumptions*" (Storjohann, 2005, p. 5), thus, this approach fits the objectives of this present study. A part of a specialised corpus namely the Malaysian Diachronic Climate Change Corpus (MyDCCC) has been developed from an online English Malaysian newspaper, The Sun Daily (https://www.thesundaily.my), for this study. MyDCCC is a monitor corpus that is still being developed concurrently targeting other online newspaper portals while looking at more year counts for the use of future studies. However, as mentioned, the researchers only looked into a part of the corpus which was the data from The Sun Daily for this present study. Newspaper was chosen for this study as it is the central agent for information propagation in most places. It acts as a central "interpretative system" (Peter & Heinrichs, 2005) as well as a central agent for awareness-raising and information (Schmidt et al., 2013). Additionally, The Sun Daily was chosen as it is one of the top digital news brands listed in Reuters Institute Digital News Report 2020 in Malaysia (Newman et al., 2020).

This data source provides easy accessibility as it is free of charge and contains broad news archives of past news up to the current time. The researchers used "climate change Malaysia" as the search term to ensure only news articles related to the term were gathered. There was a total of 509 news articles collected from May 2017 until May 2021. This duration was chosen because of two natural disasters that occurred – 1) the separation of Antarctica's A68 from the Larsen C Ice Shelf in 2017 and 2) the devastating flood phenomenon in Penang, Malaysia in the same year which became an alarming environmental issue globally and locally, (Shamil 2018). Among the 509 news articles, 112 news articles were identified as editorial news which corresponded to the objectives of this study. Since the editorial news involved the opinion genre, the researchers decided that editorial news should be used as the source to identify the public sentiments or perceptions about climate change issues. Additionally, the editorial news or columns are written by invited writers that are not directly associated with the newspaper portal as stated in the articles, hence, represents the opinions of the public.

The collected 112 news articles were then filtered by removing the duplicated and irrelevant articles to improve the reliability of the data. A detailed explanation of the filtering process follows in the next section. Upon the filtering process, 59 news articles remained to be used as the data for this study. The remaining 59 news articles made up a corpus which consisted of a total of 6, 791-word types, comprising 48,821-word tokens.

RESEARCH PROCEDURE

The present research consists of several research procedures to achieve its objectives. Figure 1 depicts the research procedures for this research. A detailed explanation of the research procedures follows next.
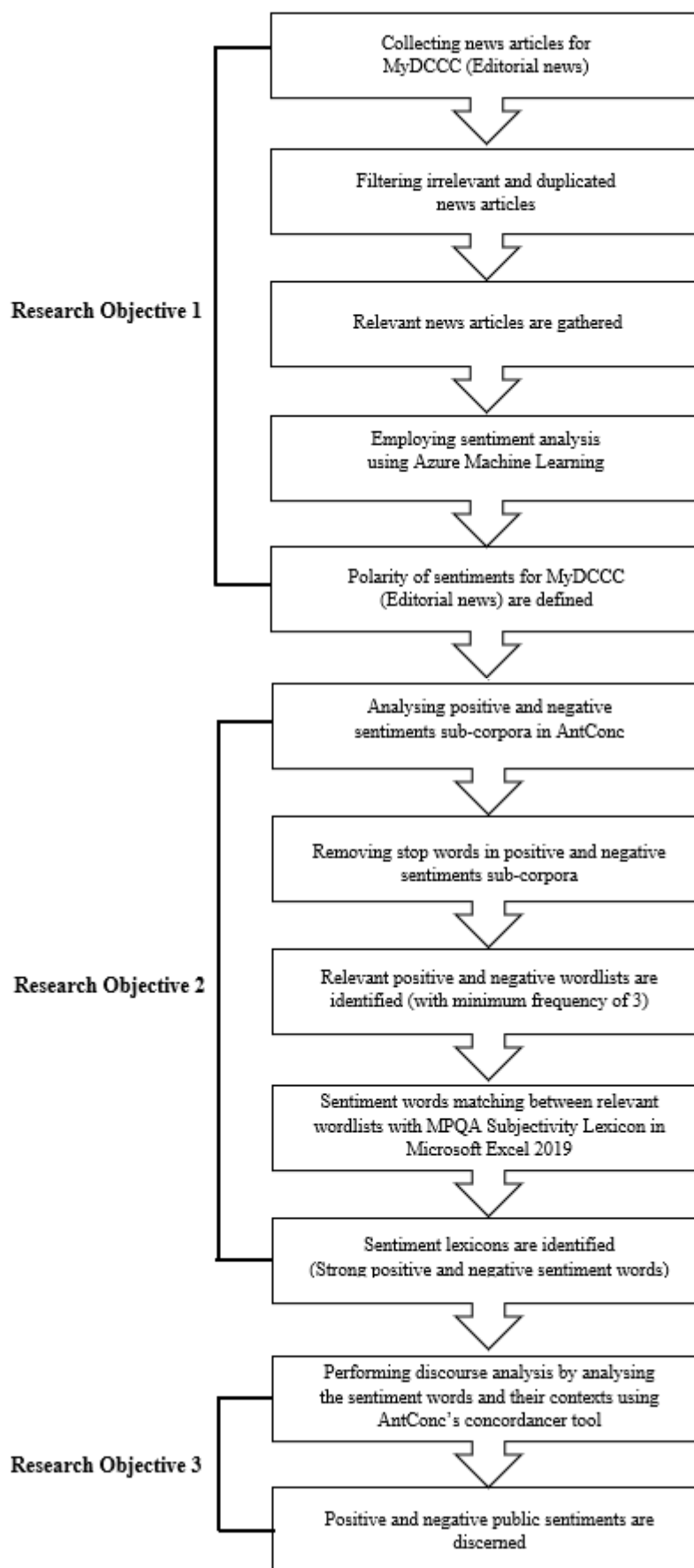
FIGURE 1. Research procedures

As mentioned, the collected news articles were filtered by emitting duplicated and irrelevant articles. The duplicated articles were removed using a third-party platform called Ashisoft (https://www.ashisoft.com/), while the irrelevant articles were removed manually by the researchers. The filtering processes lead to a total of only 59 news articles out of the initial 112 news articles. Next, the filtered news articles were converted into plain text (txt.) format to ensure the files are readable by AntConc. The converted data also went through a pre-processing stage wherein unwanted noise such as the marketing materials or advertisements, social media information and news section labels. This pre-processing stage helped the researchers to have only the relevant and significant information of the news articles such as the title, publication date, author's name, news' section and the body of the article.

The sentiment analysis software used for this study was Azure Machine Learning. The Azure Machine Learning software that was used in this study is the one that is integrated into Microsoft Excel. This software is easily accessible as it is free of charge and does not require coding skills to perform the analysis. The software is also convenient in that it may analyse large textual data such as news articles (Jelen, 2016), compared to other sentiment analysis software. Before inserting the data into Azure Machine Learning to achieve the first objective, the researchers emitted the paragraph breaks of the news articles to ensure the readability of the files in the software. After this, the sentiment analysis was performed. The analysis generated the polarity as well as the sentiment score of each news article. The sentiment score generated by Azure Machine Learning is in decimal places by default. Jelen (2017) states that sentiment score in Azure Machine Learning may be converted into percentages and the score that is close to 100% is extremely positive, whilst the score that is close to 0% is extremely negative. This also means that the score for neutral sentiment is to be measured as close as to 50%. For the present study, the researchers have decided to use decimal places for the score to observe the accuracy as well as the degree of strength of each polarity. Hence, in decimal places, the sentiment scores close to 1 is extremely positive, close to 0 is extremely negative, and close to 0.5 is neutral. By performing the sentiment analysis, the researchers also managed to find the average score for each sentiment and the total number of polarities count for all news articles.

Next, the news articles were separated into two sub-corpora which were positive sentiment sub-corpora and negative sentiment sub-corpora. These sub-corpora were then inserted into AntConc. Stop words such as *the*, *is,* and *are* of both sub-corpora were then removed using the word list range tool in AntConc to make sure that only the content words remain. Stop words are a set of words that are filtered out, or excluded from a text for text processing because they have little semantic significance (Raulji & Saini, 2017). Stop word removal (also known as stop list in corpus linguistics) is a common method in natural language processing, information retrieval as well as corpus linguistics (Anis Nadiah et al., 2021). Past studies that looked into the area of corpus linguistics including Nor Fariza et al, (2021) and Sabrina et al., (2020) have employed the filtration of stop words in their studies. Upon filtering the stop words, the wordlist tool in AntConc was deployed to find the wordlist, frequency and rank of each content word that occurred in both positive sub-corpora and negative sub-corpora. The researchers also only looked at words that attained a minimum frequency of 3 which shows that they occur 3 times in the corpus. In corpus analysis, the minimum cut-off points for the frequency range from 10 to 40 times per million (Biber et al., 1999; Simpson-Vlach and Ellis, 2010). Hence, in this present study, the researchers decided to have the minimum cut-off point set at 10 times per million words which equals to the minimum frequency of 3. The wordlists for each sub-corpus were then extracted and inserted into Microsoft Excel to match the wordlist with the Multi-Perspective Question Answering (MPQA) Subjectivity Lexicon that is used by Azure Machine Learning (Jelen, 2017).

Upon matching the wordlist generated in AntConc with the sentiment lexicon list in the MPQA Subjectivity Lexicon, the frequency, sentiment, strength of sentiment and part of speech (POS) of each word were obtained, which lead to fulfilling the second objective. This information also aided the researchers to conduct the discourse analysis while referring to the context of each news article using the concordance tool in AntConc, to achieve the third objective. Concordance window is generated using the Concordancer. Concordancer is the central tool used in most corpus analysis software, including AntConc. The main function of the concordance tool is to show how a search term is used in a target corpus (Anthony, 2005) and to display many lexical items in context (Norsimah et al., 2019).

SENTIMENT LEXICON AND MPQA SUBJECTIVITY LEXICON

Sentiment analysis may be analysed through sentiment lexicon. Lexicon based approach in sentiment analysis looks into the sentiment lexicon to determine the polarity of a given textual data (Nasim et al., 2017). Nasim et al., (2017) also add that sentiment lexicon represents a list of words associated with sentiment polarity. There are various sentiment lexicons used by various sentiment analysis software. Azure Machine Learning, as mentioned previously, which was used for this present study, utilizes MPQA Subjectivity Lexicon. MPQA Subjectivity Lexicon is a part of the OpinionFinder system (MPQA, n.d). OpinionFinder is a system that analyses documents and detects subjective statements as well as other characteristics of subjectivity within sentences, such as opinion sources, direct subjective expressions and speech events, and sentiment expressions. Hence, to identify such subjective sentiments, OpinionFinder operates using the MPQA Subjectivity Lexicon. MPQA Subjectivity Lexicon acts like a generic dictionary and contains 8,222 words: 2,719 positive, 4,914 negative and 591 neutral, for sentiment analysis and opinion mining (Khoo et al., 2018). It includes adverbs, adjectives, nouns, verbs and anypos (any part-of-speech) (Khoo et al., 2018). MPQA Subjectivity Lexicon was also developed by compiling subjectivity clues from various sources, manually developed resources, as well as automatically identified using annotated and unannotated data (Jagdale et al., 2018). MPQA Subjectivity Lexicon consists of subjectivity clues that have various types such as weaksubj, strongsubj, strong+weak as well as mixed entries (Jagdale et al., 2018). Each line in the lexicon file contains one subjectivity clue. An example is as shown below:

type=weaksubj len=1 word1=abrupt pos1=adj stemmed1=n priorpolarity=negative

TABLE 1. A part of MPQA Subjectivity Lexicon

No.	Type	Length	Word	POS	Stemmed	Polarity
1	type= weaksubj	len=1	word1= abandoned	pos1= adj	stemmed1=n	priorpolarity= negative
2	type= weaksubj	len=1	word1= abandonment	pos1= noun	stemmed1=n	priorpolarity = negative
3	type= weaksubj	len=1	word1= abandon	pos1= verb	stemmed1=y	priorpolarity = negative
4	type= strongsubj	len=1	word1= abase	pos1= verb	stemmed1=y	priorpolarity = negative
…	…	…	…	…	…	…
8221	type= strongsubj	len=1	word1= zes	pos1= noun	stemmed1=n	priorpolarity = positive

RESULTS

In this section, results based on the sentiment analysis which revealed the polarity of sentiments among the public about climate change will be presented first. Then, results of the sentiment lexicon identification associated with the public sentiments will be demonstrated. Discourse analysis will then be presented to discern the public sentiments on climate change in the news articles based on the identified sentiment lexicon.

SENTIMENT ANALYSIS

Initially, 112 news articles were identified as editorial news associated with climate change topic for this study. However, some news articles were found to be duplicates and only partially connected to the topic of climate change. This means that climate change is not mentioned as the main discussion. Therefore, as mentioned in the methodology section, the researchers removed the duplicated and irrelevant news articles to provide reliable data for this study. A total of 59 news articles remained for the analysis. The 59 news articles were inserted into Azure Machine Learning to identify the polarity of the sentiments. As mentioned, the sentiment scores close to 1 is extremely positive, close to 0 is extremely negative, and close to 0.5 is neutral. As stated in table 2, majority of the sentiments recorded from the editorial news articles are negative (90%), whilst minority of the sentiments are positive (10%). Neutral sentiment was not found in the news articles.

TABLE 2. Sentiment Analysis Score

Sentiment	Count of News Articles	Average Polarity Score	Overall Polarity Percentage
Negative	53	0.056	90%
Neutral	0	-	-
Positive	6	0.897	10%

SENTIMENT LEXICON IDENTIFICATION

Upon completing the sentiment analysis, the news articles were divided into two sub-corpora to conduct two separate corpus analyses on each sub-corpora; the negative sentiment sub-corpora as well as the positive sentiment sub-corpora. Both positive and negative sentiment words were obtained after matching the wordlist generated for each sub-corpus with the MPQA Subjectivity Lexicon in Microsoft Excel. As mentioned, for this present study, the researchers only highlighted the strong positive and strong negative sentiment words with a minimum frequency of 3.

The negative sentiment sub-corpora comprised 6,482-word types and 44,171-word tokens. There were 532 negative sentiment words in the news articles when matched with the MPQA Subjectivity Lexicon list. A total of 290 sentiment words were identified as strong negative sentiment words. The sentiment words with the strong negative polarity and a minimum frequency of 3 are presented in table 3. The negative sentiment word *long* has the highest raw frequency, which is at 28. The lowest raw frequency is 3 which comprised of following negative sentiment words - *alarming, bad, brutally, burn, corruption, debate, devastating, disruption, horrible, irony, lacking, lies, mere, merely, objections, oblivious, oppression, pain, refuse, severity, suffering* and *terrible*.

TABLE 3. Strong Negative Sentiment Words

No.	Rank	Freq	Word	Sentiment	POS
1	98	28	long	negative	verb
2	227	16	critical	negative	anypos
3	351	12	serious	negative	anypos
4	446	11	lack	negative	adj/noun
5	531	10	rubbish	negative	noun
6	551	9	blame	negative	adj/noun/verb
7	563	9	disaster	negative	noun
8	589	8	mean	negative	adj/verb
9	719	8	stress	negative	noun/verb
10	739	7	angry	negative	adj
11	758	7	concern	negative	adj/noun/verb
12	803	7	little	negative	adj
13	889	6	catastrophe	negative	anypos/noun
14	898	6	concerns	negative	adj/noun
15	910	6	doubt	negative	noun/verb
16	975	6	poverty	negative	noun
17	997	6	seriously	negative	anypos
18	999	6	slaves	negative	adj/noun
19	1024	6	worse	negative	adj
20	1083	5	concerned	negative	anypos
21	1096	5	degradation	negative	noun
22	1099	5	dire	negative	adj
23	1101	5	drastic	negative	adj
24	1164	5	mar	negative	noun/verb
25	1201	5	protest	negative	adj/noun/verb
26	1225	5	severely	negative	anypos
27	1252	5	unfortunately	negative	anypos
28	1287	4	argue	negative	verb
29	1304	4	burden	negative	adj/noun
30	1315	4	cheap	negative	adj
31	1376	4	fear	negative	noun/verb
32	1389	4	frightening	negative	adj
33	1409	4	harm	negative	adj/noun
34	1410	4	harmful	negative	adj
35	1411	4	heavily	negative	adverb
36	1422	4	injustices	negative	adj/noun
37	1426	4	irreversible	negative	adj/noun
38	1518	4	sadly	negative	anypos
39	1559	4	thirst	negative	noun/verb
40	1575	4	virus	negative	adj/noun
41	1628	3	alarming	negative	adj
42	1648	3	bad	negative	adj
43	1665	3	brutally	negative	anypos
44	1667	3	burn	negative	verb

45	1715	3	corruption	negative	noun
46	1729	3	debate	negative	verb
47	1746	3	devastating	negative	anypos
48	1755	3	disruption	negative	adj/noun
49	1850	3	horrible	negative	adj/anypos
50	1880	3	irony	negative	anypos
51	1894	3	lacking	negative	adj
52	1899	3	lies	negative	adj/noun
53	1923	3	mere	negative	adj/anypos
54	1924	3	merely	negative	anypos
55	1945	3	objections	negative	adj/noun
56	1946	3	oblivious	negative	adj/noun
57	1952	3	oppression	negative	adj/noun
58	1965	3	pain	negative	adj/noun/verb
59	2034	3	refuse	negative	verb
60	2064	3	severity	negative	noun
61	2089	3	suffering	negative	adj/noun
62	2106	3	terrible	negative	adj/anypos

The positive sentiment words were noticeably fewer compared to the negative sentiment words due to the minimal number of positive sentiments found in the news articles. The positive sentiment sub-corpora comprised of 1,444-word types and 4,650-word tokens. There were 159 positive sentiment words in the news article with 61 sentiment words as the strong positive ones. The strong positive sentiment words with a minimum frequency of 3 is displayed in table 4. The positive sentiment word *better* has the highest raw frequency, which is at 7. The positive sentiment words *best, hope, just, understand* and *vital* attained the frequency of 3.

TABLE 4. Strong Positive Sentiment Words

No.	Rank	Freq	Word	Sentiment	POS
1	38	7	better	positive	adj/anypos
2	145	3	best	positive	anypos
3	173	3	hope	positive	adj/noun/verb
4	179	3	just	positive	adj/anypos/noun
5	220	3	understand	positive	verb
6	225	3	vital	positive	adj

As the researchers went through the POS for each sentiment word that was matched to the MPQA Subjectivity Lexicon, the researchers noticed that the POS for some of the sentiment words did not coincide with the context of the articles. This is validated when the researchers did cross-check with some of the sentiment words with the concordance tool in AntConc. This will be further described in the next section. Furthermore, it is evident that the POS and the meaning of the words may vary depending on the context. Hence, this has also strengthened the need for the third objective, which is to understand further the contexts accumulated in the public sentiments.

DISCOURSE ANALYSIS

Discourse analysis was employed to discern the public sentiments based on the results of the sentiment lexicon. Excerpts of several strong positive and negative sentiments were extracted from the concordance list to discuss the contexts of the sentiment words. Three sentiment words from both strong positive and negative sentiments will be discussed.in this section.

STRONG NEGATIVE SENTIMENTS

As stated in the results section, the top three sentiment words for the strong negative sentiments are *long, critical* and *serious.*

CONCORDANCE LIST AND EXCERPTS FOR SENTIMENT WORD *LONG*

The sentiment word *long* has the highest frequency in the strong negative sentiments list. It occurred 28 times in the news articles. Figure 2 presents the concordance list for the sentiment word *long* in the negative sentiment corpus.

FIGURE 2. Concordance list for sentiment word *long*

Excerpts in examples 1 and 2 illustrated the contexts in which the sentiment word *long* were used. Although the MPQA Subjectivity Lexicon recognised *long* as a verb, the function of the word is context-dependent. The POS for the word *long* that MPQA Subjectivity Lexicon recognised is similar to the meaning of the word *desire,* which acts as a verb in a sentence. For example, "I long for you.", which shows a yearning or a prolonged unfulfilled desire or need.

Example 1: *The agriculture sector has **long** been ignored in Malaysia as the country shifted its economic focus to export-oriented industries.*

Example 2: *It is not that we are lacking in resources – we have plenty of **long** rivers but we are very poor at managing it.*

The excerpt in example 1 represents the sentiment word *long* in the context as an adverb. The context demonstrated that the agriculture sector is being ignored for a rather lengthy period of time in Malaysia and has been affected by the proliferation of dams along the Mekong River, coupled with climate change, which has increased the salinity of the river. As a result, the agriculture sector was tremendously affected.

The excerpt in example 2 shows that the word *long* was used as an adjective. The public described the poor management of rivers in Malaysia which is a useful resource that could provide multiple benefits towards a population if it is used and managed properly. In addition to that, the context of the article mentioned that modernisation and industrialisation have led to increase the water pollution, which is seen as one of the climate change causes.

Though the meaning of the sentiment word *long* recognised by the MPQA Subjectivity Lexicon portrays a different meaning compared to the context that appeared in the news articles, most of the occurrences of the sentiment word *long* in the news articles still portrayed negative background.

CONCORDANCE LIST AND EXCERPTS FOR SENTIMENT WORD *CRITICAL*

The sentiment word that has the second-highest frequency in the strong negative sentiments list is *critical,* with 16 occurrences in the news articles. Figure 3 demonstrates the concordance list for the sentiment word *critical.*

FIGURE 3. Concordance list for sentiment word *critical*

Excerpts in examples 3 and 4 depict two of the contexts for the sentiment word *critical* in the news articles. The POS of the word *critical* in the MPQA Subjectivity Lexicon is identified as anypos, which means that it could stand as any part-of-speech depending on its context.

Example 3: *Also* **critical** *are issues such as energy; replacing polluting technologies with environmentally sound technologies; protecting the marine environment and wetlands; conserving biodiversity; and replacing chemical-based agriculture with sustainable agriculture.*

Example 4: *As Malaysia is already 76% urbanised, the importance of living in harmony with nature is even more* **critical***.*

As demonstrated in example 3, the sentiment word *critical* is an adjective. It described the critical environmental concerns. In the news article, the author sought to have various ameliorations in addressing climate change, which included an improved Environmental Protection Act that addresses the weaknesses of the previous legislation, that involved regulations on environmental impact assessments in Malaysia. This context also implied the regret that the public had towards how the decision-makers were administering climate change issues. The sentiment word *critical* in example 4 is identified as an adjective. The context in example 4 demonstrated how urbanisation in Malaysia is seen as a critical matter that is affecting the nature. In the context, the author in example 4 called for more precautionary attention towards the urban development in Malaysia.

CONCORDANCE LIST AND EXCERPTS FOR SENTIMENT WORD *SERIOUS*

The final sentiment word that will be discussed for the strong negative sentiments is *serious*. It had 12 occurrences in the news articles. Figure 4 represents the concordance list for the sentiment word *serious*.


```
        more pressure or even  serious accidents . The Australian authorities
     wastes . We have experienced  serious cases of air and
        or downplay the equally  serious climate change challenges .   The
            the people will take  serious concerted efforts to make
           which there will be  serious consequences for global food
       climate reality " or face  serious costs , damages and losses .
          . Some of the most  serious fires occur in peatlands ,
       Malaysians don't read  serious non-fiction books that
       " . Plastic pollution is a  serious problem globally . It ranges
              can also lead to  serious public health problems and
          . While we are facing  serious risks from climate change
   global health emergency pose  serious risks to human welfare
```

FIGURE 4. Concordance list for sentiment word *serious*

Examples for the usage of the sentiment word serious are demonstrated in examples 5 and 6. The sentiment word *serious* is also identified as anypos based on the MQPA Subjectivity Lexicon.

Example 5: *Hence, it is important that governments, preoccupied with Covid-19 management issues, do not overlook or downplay the equally **serious** climate change challenges.*

Example 6: *This can also lead to **serious** public health problems and air and water pollution.*

Both of the excerpts used the sentiment word *serious* as an adjective. The excerpt in example 5 described climate change challenges as something serious that the government should not overlook though given the hectic current Covid-19 issue. In the context, the author showed his worry about the impacts of climate change. The excerpt in example 6 stated the effects that may be brought by waste-dumping. The main context of the news article in excerpt 6 portrayed that the author had an inclination of better waste management practices in Malaysia, which is lacking in the country.

STRONG POSITIVE SENTIMENTS

As stated in the results section, the top three sentiment words for the strong positive sentiments are *better, best* and *hope*. The discussion of the contexts of each sentiment word is demonstrated below.

CONCORDANCE LIST AND EXCERPTS FOR SENTIMENT WORD *BETTER*

The sentiment word *better* has the highest frequency in the strong positive sentiments list and it occurred 7 times in the news articles. Figure 5 depicts the concordance list for the sentiment word *better* in the positive sentiment corpus.

FIGURE 5. Concordance list for sentiment word *better*

Excerpts in examples 7 and 8 depict two of the contexts for the sentiment word *better* in the news articles. The MPQA Subjectivity Lexicon identified the word better as an adjective and anypos. Both excerpts in example 7 and 8 shows the POS of the sentiment word *better* as an adjective.

Example 7: *We have the knowledge, technology and capability to move towards a **better** future for people and nature.*

Example 8: *The next few years are, in fact, critical to put the planet on the path to a **better** future.*

The main context of examples 7 and 8 described the demanded global movement towards the mitigation of climate change among the public in Malaysia. The news article also referred to the implementation of Earth Hour 2019. As stated in example 7, the author

motivated the public with the available resources that they have that could be used to safeguard the future for the people and nature. In example 8, the author urged the people to do better in order to secure the future.

CONCORDANCE LIST AND EXCERPTS FOR SENTIMENT WORD *BEST*

Next, the sentiment word *best* will be discussed. Although this sentiment word attained a low number of frequency of 3, it is still comprised as a strong positive sentiment word based on the MQPA Subjectivity Lexicon. Figure 6 demonstrates the concordance list for the sentiment word *best*.

> and democracy are the best guarantees for Malaysian ecology ,
> the rural folk is best posed in such a
> young " says it is best to start the message

FIGURE 6. Concordance list for sentiment word *best*

Both examples 9 and 10 portray the sentiment word *best* as an adjective based on their contexts. As mentioned in the results section, MPQA Subjectivity Lexicon identified *best* as anypos. The excerpts for examples 9 and 10 are as shown below.

Example 9: *In other words, there is a need for a sustainable development and planning to meet the challenges of climate change and the economy – decentralisation, diversification and democracy are the **best** guarantees for Malaysian ecology, food security and the rights and interests of the people.*

Example 10: *Indeed, "Catch them young" says it is **best** to start the message of sustainability with our young children.*

The excerpt in example 9 demonstrated the proper steps that aid the sustainable development and planning, whilst the excerpt in example 10 stated that the insights of sustainability should be adopted at a young age. Both contexts in examples 9 and 10 presented that the authors were fully conscious of the best steps that need to be taken to act on climate change.

CONCORDANCE LIST AND EXCERPTS FOR SENTIMENT WORD *HOPE*

The sentiment word *hope* has a frequency of 3 in the strong positive sentiment corpus. Similar to the sentiment word *best*, as described above, this sentiment word shall be described as well as it belongs in the strong positive sentiment list. Figure 7 represents the concordance list for the sentiment word *hope* in the negative sentiment corpus.

> of solution options , we hope that broader and longer-
> the Klang Valley and hope that these , together with
> Financing Incentive package , and hope this will contribute towards

FIGURE 7. Concordance list for sentiment word *hope*

The MPQA Subjectivity Lexicon recognised the sentiment word *hope* as an adjective, noun and verb. The contexts of the sentiment word *hope* in examples 11 and 12 below treat the word as a verb. The excerpts for examples 11 and 12 are presented below.

Example 11: *We are also keen to hear more about the RM98.5 million that has been allocated for the Fishermen Financing Incentive package, and* **hope** *this will contribute towards the sustainable management of our fisheries.*

Example 12: *We applaud the introduction of bus and rail passes within the Klang Valley and* **hope** *that these, together with the expansion of the free GoKL bus services and the revival of the LRT3 and MRT2 lines will help more commuters take public transport.*

The excerpts in examples 11 and 12 appeared in the same article. The author looked into the budget announcement made by a former Finance Minister, Lim Guan Eng, which was related to the budget allocation of the sustainable development plans in Malaysia. In example 11, the author stressed that he urged to witness the implementation of the promised budget made by the government. The excerpt in example 12, on other hand, depicted the same author to be obliged with the implemented public transportation plan by the government which may help to lessening the impact of climate change.

DISCUSSION

This present study has examined Malaysian public sentiments about climate change in an online English Malaysian newspaper, The Sun Daily. The editorial news articles, which is the data source for this present study, were perceived as public sentiments. The news articles comprised various climate change topics which include the perceptions of the public to matters such as implementation of government policies, the impacts of climate change, the steps that should be taken to mitigate climate change as well as the inadequacy of the government and the individuals in the nation in mitigating climate change effects. The results revealed that the polarity of the public sentiments in the online newspaper appeared to be mostly negative. Only a minority of the public perceived climate change as positive. Neutral sentiment, however, was not detected among the public in the news articles.

The word matching with MPQA Subjectivity Lexicon has produced the list of strong positive and negative sentiment words that were used in the sentiment lexicon identification. The sentiment lexicon identification has indicated that there were a relatively large number of negative sentiment words although the corpus used for this study was relatively small. It consists of 532 overall negative sentiment words and comprises 290 strong negative sentiment words. This has supported the high occurrence of the 90% polarity of negative sentiments identified in this study. The significant negative sentiment words listed are *long, critical* and *serious,* with 28, 16 and 12 occurrences in the news articles, respectively. On the other hand, the positive sentiment words found were 159, while 61 words were the strong positive ones. The top three words are identified as *better, best* and *hope.* Although some words recognised by the MPQA Subjectivity Lexicon have different POS and meanings when compared to the actual contexts, the polarities of the sentiment words remained. For instance, the negative sentiment word *long* in MPQA Subjectivity Lexicon is identified as a verb, rather than an adjective when referred to the actual context in the news articles. The word *long* in MPQA Subjectivity Lexicon is described to have a similar meaning to "yearning" or a "prolonged unfulfilled desire or need", which explains why the lexicon dictionary perceived it as a verb. In contrast to the MPQA Subjectivity Lexicon, the word *long* in our context describes an adjective that denotes the size, quantity and time when referred to Bieber et al., (1999)

descriptor category for adjective. However, despite the differences that emerged, the word *long* in our context remained negative as described by the MPQA Subjectivity Lexicon. This means that the sentiment word classification by MPQA Subjectivity Lexicon is reliable and accurate.

Where the negative sentiment is concerned, the word *long* used as an adverb and an adjective in two different contexts appeared to be negative. One of the contexts also describes the long-ignored agriculture sector affected by the proliferation of dams along Mekong River as well as climate change. The word *critical,* which is an adjective, is seen as negative as well. It describes the critical issues that should be mitigated while portraying regret in the poor administration by the decision-makers on climate change. The critical state of the nature affected by urbanisation in Malaysia is also described in another context of the word *critical.* Public complaints about urbanisation in the corpus might be triggered by the rising developments in Malaysia that is critically affecting nature. This is evident from the increasing rate of urban population in Malaysia from 70.91% in 2010 to 77.16% in 2020 (O'Neill, 2021), which has obviously increased the development of many new urban buildings and residences in the country, rejecting the nature sustainability. Next, the negative sentiment word *serious,* used as an adjective, portrays a worrying context that highlights climate change challenges as something serious that the government should not overlook given the current Covid-19 issue. The context of the word *serious* also mentions how waste-dumping may lead to serious issues of public health problems, air and water pollution. Waste-dumping in Malaysia is seen as a serious problem. One of the reasons is that the country has been a waste-dumping target. Following China's ban on imports of plastic waste in 2018, Malaysia has become the preferred destination for the world's plastic waste (Ananthalakshmi, 2021) and this is clearly affecting all Malaysians in various aspects of life consciously or subconsciously.

For positive sentiments, the word *better* which is used as an adjective in the contexts, states the demand for the global movement towards the mitigation of climate change in order to secure a better future. On the other hand, the word *best*, which acts as an adjective, depicts both authors in both contexts appeal to be fully conscious of the current situation of climate change and are aware of the best steps that need to be taken to mitigate climate change. There is no denying that the notion of what climate change is and how to ameliorate the issue are beginning to accommodate the public's concern and voices, be it locally or globally. This is aligned with a study made by Voskaki et al., (2015) which claim that majority of the public respondents in Greece agrees that climate change is seen as a problem, while 77% of the public in the study have already taken some measures to fight climate change since the year 2000. Finally, the word *hope* that occurred to be a verb in both contexts, demonstrates the high hope that the public has towards the government in the promised sustainable development plans. Another context of the same word for *hope* also states that the public feels obliged with the currently implemented public transportation plan made by the government and hope that it could help to lessen the impact of climate change.

Despite the constructive positive sentiments, the overall findings of the research depicted that majority of the public perceived climate change negatively. However, the negative sentiment contexts show that the public is reasonably insightful of climate change although their sentiments appeared to be negative. This concurs with the study made by Yu et al., (2021) which states that the public does possess some basic knowledge about climate change. Similarly, Wan Nur Syamilah and Nasuha (2021) also claim that 66% of their respondents who are based in Malaysia also have a high literacy about climate change. Based on the context in our corpus, the public understands the basis of climate change but is rather flustered with the current situation given that the people of the nation, as well as the decision-makers in Malaysia, are less aggressive in addressing the issue. This is evident through one of the news articles, from the sentiment word *critical*, that states the poor management of Malaysian decision-makers in addressing climate change issues. Lorencová et al. (2019) state

that individual efforts in mitigating and adapting to climate change shall be supported by a consistent climate policy. The negative sentiments and their contexts which are found in this study may be an indication for the decision-makers to improve their approach in addressing, mitigating, and adapting to climate change. Ironically, the contexts of these negative sentiments demonstrate the inconsistent and unaggressive climate change policies implemented in the country, which perhaps act as the factor that holds back the public from having the demanded positive sentiments. An understanding of the public's perceptions towards climate change issues may help the decision-makers to produce the proper adaptation and mitigation plan (Lorencová et al., 2019; Dahal et al., 2021). If the decision-makers try to understand the public sentiments as well as the contexts or causes of the sentiments, they may improve their approach to change the society's perceptions towards climate change issues.

CONCLUSION

This study has explored the sentiment polarities, sentiment lexicon and discourse contexts associated with climate change to find out how Malaysian public perceives climate change and the underlying notion that made up such sentiments, over a period of five years in an online English Malaysian newspaper, The Sun Daily. The results revealed that the perceptions towards climate change issues among the public appeared to be mostly negative, highlighting the public's exasperation towards how climate change issue is handled by the decision-makers. Whilst positive sentiment among the public is seen as a paramount component to aid the mitigation and adaptation of climate change, we can conclude that if the decision-makers attempt to understand the public sentiments as well as the contexts or causes of the sentiments, they may produce an improved approach to change the society's perceptions to be more positive.

Whilst individual efforts in mitigating and adapting to climate change depend substantially on consistent climate policies (Lorencová et al., 2019), the effort of understanding the sentiments or perceptions among the public towards climate change may help in structuring the proper adaptation and mitigation plan by the decision-makers (Lorencová et al., 2019; Dahal et al., 2021). Based on the findings, it is evident that the reinforcement of the climate change policies by the decision-makers is merely the action demanded by the public given that the public is already reasonably insightful of climate change. By rectifying this issue, higher positive sentiments among the public may be achieved. Furthermore, having society establish positive sentiments about climate change may influence a higher possibility of lessening the worrying impact of the climate change that is currently happening.

This study has its limitation in that only one newspaper was chosen as the source of data collection and due to time constraints the data was collected for a period of five years. Hence, future researchers are suggested to increase the number of newspapers and the period of data collection to produce extensive, comparable and more stable results. A comparative study can also be conducted between different news sources which will allow them to explore the diversity in climate change focus. Additionally, this research only discussed the factors that influenced public perceptions based on the context of news articles. Hence, future researchers may consider other sources such as social media that may influence public's perceptions. Despite its limitation, the present study has added to the literature and the research on public sentiments and sentiment lexicon on climate change in the Malaysian context, since the review of the literature revealed that the studies focusing on this are lacking in the country. In addition, this research has contributed significantly to studies on climate change in Malaysia from the linguistics perspective.

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