



# Exploring the informal learning of zero waste lifestyle in Malaysia with big data analytics

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## ABSTRACT

Malaysia's solid waste generation is showing a worrying increasing trend, while public awareness towards achieving zero waste remains low. As a big data resource, social media gives valuable insight into the public's perspective on zero waste and, as such, may be fully utilized as an active informal learning platform to lessen the reliance on formal environmental education. Using big data analytics on Instagram, this study aimed to assess the public knowledge, attitude and practice concerning zero waste lifestyle in Malaysia in order to develop an informal learning strategy on social media. Purposive data sampling was conducted on Phantombuster using zero waste-related Instagram hashtags, which yielded 1723 high engagement posts and 1500 comments from 35 identified hashtags. The recorded posts were analyzed using descriptive statistics and sentiment analysis on Python's TextBlob. A total of 94.3% of posts were published by public and private sector accounts, highlighting their vital role in facilitating active knowledge sharing across the online zero waste communities. The sentiment analysis results indicated 41.3% of comments were fairly positive, while 36.1% were more objective and knowledge oriented, acknowledging the collective individual actions that have initiated influential social change in Malaysia. This study advances the existing literature on zero waste and informal learning by recommending the use of big data analytics on social media in the local context. Only with full commitment from all parties to raising public awareness about waste management will the zero waste nation be realized.

## 1. Introduction

### 1.1. Literature review

Municipal solid waste (MSW) poses great environmental risks as it is expected to exceed two billion tonnes per year globally (MIDA, 2021; Zulkifli et al., 2019). Based on the notion of fast-growing population and rapid development, these piled-up trashes contribute to plastic pollution, leachate leakage, foul odors and unpleasant aesthetic view that affects the quality of life (BERNAMA, 2021). The waste problem itself is a much wider subject with numerous dimensions, each with their own societal, economical, and environmental impacts (Ab Aziz et al., 2022; Irani et al., 2018; Suratman, 2020).

Developing countries typically create less MSW than developed countries. However, according to the government's report, Malaysia's overall household waste generation is showing a worryingly increasing trend, from 36,500 tonnes per day in 2015 to 38,150 tonnes per day in 2018 (SWCorp, 2020), with annual growth of 4% (Mohd Rodzi et al., 2019). In 2021, the estimated waste generation rate for Malaysia is 1.17

kg per capita per day, which is significantly higher than the average worldwide of 0.74 kg (EPU, 2021; MIDA, 2021). Malaysia even generates more waste compared to its neighboring countries, such as Indonesia and the Philippines, with 0.22 kg and 0.4 kg, respectively (Chen et al., 2021). A greater disposal rate has been reported in urban areas, whose consumption behaviors and changing lifestyles are shaped by advancements in the standard of living, technological innovation, and the proliferation of shorter-lasting, single-use, and disposable products in the market (Mohd Rodzi et al., 2019).

Malaysia, like the vast majority of Southeast Asia's developing countries, has insufficient waste management systems to handle the volume of waste generated and to adequately cover waste collection nationwide (Suratman, 2020). As of 2017, the country's primary method of dealing with MSW is landfill disposal, with the remaining waste either incinerated (26.5%) or recycled (17.5%) though domestic burning occurs on an isolated basis (Mohd Rodzi et al., 2019).

While landfill mining and waste-to-energy incinerator projects offer alternatives for treating trash and recovering potentially valuable resources (Burlakovs, et al., 2013), these technologies are entirely foreign

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in Malaysia. Hence, sanitary landfills are critically nearing capacity and waste overloading (Moh and Abd Manaf, 2017), particularly given Malaysia's low recycling rate of only 30.7% in 2020, despite of high recyclables proportion in its waste composition (Mohd Rodzi et al., 2019). As the government spends a high amount to manage this endless burden, this has resulted in bottlenecks to the growth of the economy and health consequences for communities. Hence, efforts must be stepped up to alleviate the country's waste management problem through impactful and realistic strategies by promoting waste reduction from the start.

Yet, the national development agenda and policies developed to achieve the 2025 recycling target of 40% (EPU, 2021), such as the Solid Waste and Public Cleansing Management Act 2007 (Act 672), No Plastic Bag Day campaign, plastic straw ban and 0.20 MYR levy on plastic bag has not been enforced seriously. This policy's inconsistent implementation as well as widespread ignorance and disinterest among the public and businesses, leaves huge gaps in knowledge, attitude, and practice among Malaysians nationwide (Moh and Abd Manaf, 2017).

Realizing that public awareness is still lacking, education significantly offers a solution to nurture waste segregation and recycling as habits. The sense of environmental responsibility can be established in the formal educational institutions (Wu et al., 2019). However, it necessitates a significant change in the curriculum, as well as major financial allocation and time commitment. As a result, informal learning of waste management must be thoroughly explored in every medium possible, including social media, to ensure that effective environmental education able to change people's attitudes and behaviors to adopt green practices.

Social networking site, often known as social media is a network of Internet-based services that allows users to create and share content within an online community, along with reading posts, watching videos, and following hashtags. As primary information source and medium for expression, the rising use of social media has altered how individuals worldwide acquire knowledge which, has motivate researchers to analyze the user-generated contents (Aljameel, et al., 2021; Bazzaz Abkenar et al., 2021; Niknam et al., 2020). Gleason (2013) proposed that informal learning through social media is an active constructivist process in which linkages among different views and ideas are collaboratively and inclusively constructed. Past studies have demonstrated that campaigns, which run as social media educational content, play an essential role in shaping users' views, ultimately leading to behavioral changes (Maulidini and Sumarwan, 2022).

Social media are characterized by big data's volume, veracity, value, velocity, and variety. Media sharing networks such as Instagram serve as social data sources as they offer a large volume of information via posts, captions and comments. Instagram data is also reliable, cost-free, readily available, and up-to-date. Valuable users' data can be extracted using the Application Programming Interface (API) or web crawlers. These unstructured Instagram data is also generated at a high rate in terms of velocity and can be accessed quickly, with at least 95 million posts getting published daily (Flynn, 2023). Meanwhile, numerous sources and formats add to the variety of Instagram data in the form of photos, videos, or mixed media uploads (Bazzaz Abkenar et al., 2021; Guo et al., 2020; Mishra and Singh, 2018; Zhang et al., 2021). Hence, a wealth of public perspectives on waste management are communicated on social media, which can be applied by all stakeholders in designing their waste minimization strategy.

Big data analytics are typically exploited to extract relevant details from social data, which includes sentiment analysis, content analysis, and descriptive analysis (Mishra and Singh, 2018). Unlike survey questionnaires and online ratings, which provide structured data, users' reviews, reactions, opinions, and feedback abundant in social media are unorganized textual data, scattered and spontaneous in type, which cannot be analyzed directly. However, these useful social data may still be processed and mined by converting them into quantitative information for subsequent analysis. Opinion mining, also known as text mining,

is an emerging field of data mining and is often used as a potential tool to extract valuable information from such raw data (Aljedaani et al., 2022; Papadopoulos et al., 2017; Zhang et al., 2021).

The idea of zero waste initially emerged in year 2000 for industrial purposes with the target of reaching zero-defect manufacturing while addressing climate change. Only when Béa Johnson began documenting her practices through her own Zero Waste Home blog and book, did community participation in zero waste begin to spread globally in 2013. Social media networks appear to have contributed significantly to its expanding popularity, with the emergence of hundreds of zero waste Facebook groups and pages alone. The zero waste lifestyle is described as the mindful consumption of goods and services that pushes individuals to live as waste-free as possible, with recycle being used as a last resort (Ramjaun, 2021). In Malaysia, Zero Waste Malaysia was founded in 2016 and at present has 48 thousand members in its Facebook group and 19.6 thousand followers on Instagram (ZWM, 2022). Malaysian zero waste communities have expanded further with the opening of zero waste stores, particularly within the Klang Valley.

As opposed to social movements that are aimed towards authority structures and governments, lifestyle movements are more internally oriented groupings that focus on contributing to societal changes by promoting more engaged and informed individualized actions. Alternative lifestyles, such as zero waste, challenge mainstream cultural practices and norms and can therefore be considered a lifestyle dimension of the current climate change's social movement (Spiteri, 2021). Thus, its online communities are committed to actively and consciously inspiring zero waste living by instilling a recycling mindset and changing the public perception of solid waste as the municipality's problem.

While many studies on big data analytics have been conducted on social media, notably on marketing and health care issues, very few have comprehensively addressed the zero waste lifestyle in a specific country, particularly in the context of informal learning. These studies are summarized in Table 1. As Table 1 illustrates, a number of studies have evaluated public opinion and practice on a variety of issues using social media. Many of the studies covered here, however, employed a manual coding approach, which necessitated social science knowledge.

According to Data Reportal, Malaysia has 26.80 million active social media users in January 2023, with a penetration rate of 78.5% of the 34.13 million overall population. In reality, there has been no obvious reduction in social media usage in Malaysia since 2013. Currently, 99.8% of Malaysia's population aged 18 and above use social media on at least one platform. Young adults aged between 18 and 34 years old make up the highest proportion of social media users (53.7%), notably on Instagram. Malaysians spend around 2 h and 47 min daily on social media, more than the time spent reading newspapers and listening to radio broadcasts. Additionally, reading news items and finding content such as videos are among the other key reasons Malaysians use social media, especially given the unrestricted access of social media's public posts to any internet user and its phone's user-friendly features (Kemp, 2023).

## 1.2. Problem statement

Regardless high penetration rate and significant time spent on social media, many Malaysians are still unaware of the zero waste. There were only 28,036 Instagram posts related to the #zerowastemalaysia hashtag as of April 29, 2023, which is very low (0.3%) compared to the global #zerowaste (10,714,197 posts) or the neighborhood #zerowasteindonesia (57,392 posts) and #zerowastesg (35,648 posts). Since Instagram is believed to be the most favored and leading platform for online zero waste communities compared to Facebook or YouTube (Spiteri, 2021), this suggests that Malaysia's authorities are not fully utilizing Instagram to promote zero waste lifestyle. Therefore, the immense potential of social media should be exploited to instil a sense of environmental responsibility among Malaysians through informal learning.

**Table 1**  
Summary of related studies on social media.

Study	Purpose	Approach	Data source	Dataset
<b>Marketing</b>				
Mishra and Singh (2018)	Descriptive analysis and content analysis of dissatisfaction with beef products	(Not mentioned)	Twitter	(Not mentioned)
Aljedaani et al. (2022)	Sentiment analysis on US airline industry	Machine learning and TextBlob	Twitter	14,640 tweets
Chen, et al. (2023)	Portugal’s hotel booking cancellation prediction	Integrated machine learning	Personal name records (PNR) data	>100,000 samples
<b>Healthcare</b>				
Niknam et al. (2020)	Thematic analysis on COVID-19 in Iran	Manual coding	Instagram	1612 posts
Guo et al. (2020)	Descriptive statistics and temporal distribution analysis on COVID-19’s impact to orthodontics services	Inductive and deductive manual coding	Weibo	4484 posts
<b>Waste management</b>				
Ramjaun (2021)	Textual analysis and thematic analysis of #zerowaste lifestyle	(Not mentioned)	Instagram	313 posts
Spiteri (2021)	Thematic analysis on zero waste lifestyle movement	Inductive manual coding	Instagram	2000 comments
Maulidini and Sumarwan (2022)	Content analysis on Indonesia’s food waste campaign	Direct rating method	Instagram	200 posts
Gong et al. (2022)	Network analysis and text topic analysis on China’s Zero-Waste City policy communication	Machine learning	Weibo	13,634 posts
<b>Others</b>				
Gleason (2013)	Descriptive statistics and content analysis on US Occupy World Street Movement	Inductive manual coding	Twitter	294 tweets
Papadopoulos et al. (2017)	Content analysis on Nepal’s disaster management	(Not mentioned)	Various sources	36,422 items

1.3. Research objectives

The goal of this study is to assess the public knowledge, attitude and practice concerning zero waste lifestyle in Malaysia through Instagram towards developing informal learning strategies for waste management on social media platforms.

1.4. Significance of study

To our knowledge, this is the first study that integrates zero-waste social media analytics with informal learning. That is, by outlining strategies for publishing more constructive knowledge sharing, this study contributes to the literature on sentiment analysis and zero waste. Thus, the study’s findings will help policymakers develop effective communication by prioritizing impactful social media campaigns in promoting zero waste in resource-limited events. A vast amount of social data is accumulated in Malaysia yet remains untapped, implying that social media analytics are necessary. Hence, this quantitative study focused to better inform Malaysia’s internalized context as a developing country with urgent demands to minimize waste generation and enhance its waste management. This study will be confined to explore the zero waste lifestyle and excludes other environmental issues and broader environmental topics such as green technology, energy and water conservation, or environmental preservation.

2. Methodology

2.1. Research design framework

This exploratory study on Instagram focuses on the zero waste lifestyle in Malaysia. Phantombuster was used to perform purposive data sampling and scraping of zero waste-related Instagram posts. The included postings were then evaluated using descriptive statistics and sentiment analysis to assess Malaysians’ public knowledge, attitude, and zero waste practices. Following that, zero waste informal learning strategies on social media were developed that can be utilized by all stakeholders to increase public participation in environmental governance. Fig. 1 depicts the research design framework employed in this study.

2.2. Study area

Instagram was chosen as the study focus as it is among the most popular social media platforms among Malaysians, with 13.90 million Instagram users as of January 2023. Although Instagram has a slightly lesser number of Malaysian users compared to Facebook, which has 20.25 million users (Kemp, 2023), Instagram has its own niche and is a popular image sharing platform. Also, Instagram is the most preferred site for reporting events and breaking news, where Malaysians openly voice their concerns and offer plentiful public opinion (Dixon, 2023). Instagram accounts are made up of a series of content posted by the account holder as well as community comments resulting from the postings (Spiteri, 2021). Captions are textual content in the posts, whereas comments are the responses to the content. Unlike Facebook, which has a variety reaction buttons, Instagram only has a like button.

2.3. Data collection techniques

Purposive data sampling was used to collect data on associated Instagram posts from March 24 to May 20, 2023. Potential zero waste hashtags in Malaysia, such as #zerowastemalaysia and #taknakstraw (no to straw) were identified and retrieved. In social media analytics, hashtags serve the same purpose as the search function in Google, by providing a real-time query for extracting a broad spectrum of information and in-depth analysis on a pre-existing topic. It also allows individuals in contributing to discussions with a larger community of people who share similar interests (Mishra and Singh, 2018). This implies that hashtags could signify a dynamic informal learning environment, serving users with multiple perspectives to synthesis a better-informed viewpoint. As a result, it was predicted that posts gathered from these data sets would contain a high percentage of required information that could be helpful in developing informal learning strategies about zero waste.

Phantombuster, a third-party web scraping crawler, served to retrieve all related Instagram posts and extract the metrics from every single full-text post, including caption, post URL, user accounts, date posted, number of likes, comments, views, media types, and hashtags list. This was made possible given Instagram data’s complex nature, which aids in capturing information through a reasonably wide number of indicators (Mishra and Singh, 2018). After removing duplicate posts, the remaining accessible posts were screened to find qualifying posts. Only unique posts about Malaysia’s zero waste, such as 3Rs practices

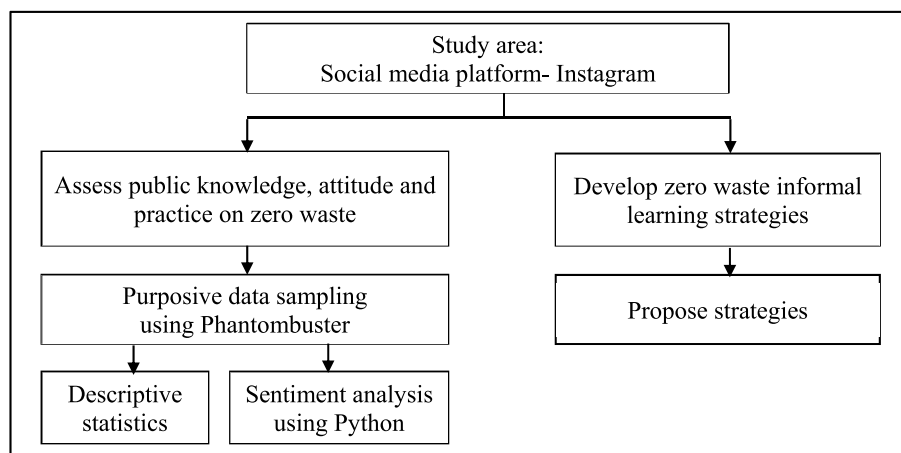


Fig. 1. Research design framework.

(reduce, reuse and recycle) and waste problems, were included as previously decided. Posts that were irrelevant to the topic of interest or which contain uninformative commercial advertising were excluded.

The unique posts were then further filtered by selecting only posts with high engagement in English. A high engagement post represents top post that meets one of the following three criteria: it has more than 100 likes; it has 50 to 99 likes with at least three comments; or it has a video attached with at least 100 views. Meanwhile, an English written post includes a post with captions or pertinent comments written in English or a different language but is capable of being auto-translated into English; thus, non-textual postings were also eliminated. In total, 1723 unique posts and 1500 comments were recorded.

#### 2.4. Data analysis and interpretation

Descriptive statistics were employed to summarise the features of the included high engagement posts. Following that, sentiment analysis was performed to mine the users' written contents about zero waste. Sentiment analysis is a study area that investigates the public's perceptions, feelings, attitudes, and views about a variety of issues and topics and can be categorized into lexicon-based, machine learning-based, and hybrid techniques. In this study, TextBlob, a freely available Python library, was utilized to conduct sentiment analysis on the recorded comments in order to evaluate Malaysians' public knowledge and attitude towards zero waste. TextBlob is among the most preferred lexicon-based models since it has a compact collection of predefined sentiment wordlists used to extract subjectivity, orientation, and polarity from the textual data. It has pre-trained machine learning approaches to perform useful Natural Language Processing (NLP) tasks, such as predicting the text's sentiments (Aljameel, et al., 2021; Bazzaz Abkenar et al., 2021; Mishra and Singh, 2018; Zhang et al., 2021).

A specific coding language was applied to generate both the polarity and subjectivity scores in Python, which were then tabulated in Microsoft Excel. Afterward, several zero waste practices highlighted in the posts' captions were documented. The data analysis inputs were then used as a guide to construct informal learning strategies for waste management on a social media platform.

It has been suggested that the sentiment analysis be conducted using machine learning or deep learning techniques that provide higher prediction and classification accuracy to avoid any possible loss of useful information (Chen et al., 2023; Zhang et al., 2021). However, due to the researchers' limited programming expertise, this study only applies TextBlob due to its ease of use and the simple sentiment analysis tasks required to inform the public perspectives about zero waste. Besides, recorded comments to be assessed have been filtered from any informal vocabulary that is excluded in TextBlob dictionary (Aljedaani et al.,

2022).

### 3. Results and discussion

#### 3.1. Descriptive statistics

A total of 35 relevant hashtags with high engagement posts were found to be related to the zero waste lifestyle in Malaysia. Because hashtags are case-sensitive, hashtags with similar focus but have different spellings were recognized as identical. While there have been 83,744 posts published with selected hashtags as of May 20, 2023, only public data can be accessed because it relies on freely accessible information on the Internet, resulting in only 37,790 posts were accessed. As a result, the privacy settings in this social media study were complied with, as only public postings were collected with no personal or confidential details of the research subjects being engaged (Guo et al., 2020). Only 1723 unique posts were recorded after additional filtering and redundancy elimination.

To ease identification, these 35 relevant hashtags were divided into 7 categories, which actually represent the purposes of these hashtags. The categories include promoting general 3R campaigns (3R), plastic waste reduction (*Plastic waste*), fabric circularity (*Fabric*), food waste reduction (*Food waste*), NGOs and community voluntary projects (*Voluntary projects*), recycling initiatives by corporations and businesses (*Business initiatives*), and campaigns by MSW-related agencies (*Agencies campaigns*). Table 2 summarizes the hashtag categories as well as the number of unique posts recorded with popular hashtags of more than 50 high engagement posts were highlighted.

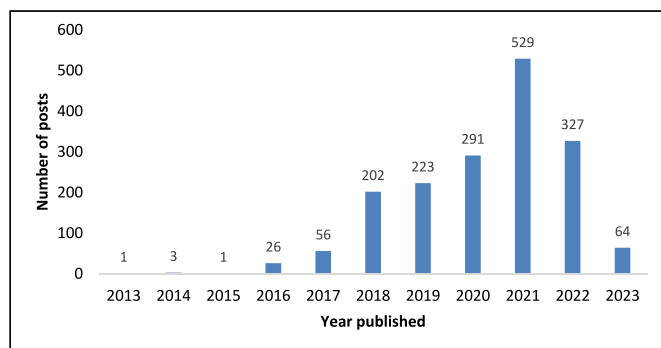
According to the hashtag analysis given in Table 2, among the popular hashtags identified were #zerowastemalaysia (and #zerowasteMY) which is created by Zero Waste Malaysia (ZWM) and #klothcares by Kloth Circularity with 586 and 179 high engagement posts, respectively. Both hashtags represent campaigns launched by these organizations. Meanwhile, other popular publicly known hashtags include #taknakstraw (no to straw) and #kitarsemula (recycle) with 205 and 193 high engagement posts, respectively. This study, however, did not investigate the frequency of the total daily posts published per hashtag due to limited access to Instagram data.

A descriptive analysis of important Instagram data collected from all recorded high engagement posts was performed. All of these popular posts were published between December 22, 2013, and May 19, 2023. Fig. 2 depicts a summary of the year of publication for the listed postings. The number of recorded posts associated to zero waste in Malaysia increased from 26 posts (1.5%) in 2016 to 529 posts (30.7%) in 2021, which is directly proportionate to the increasing trends of social media penetration countrywide. High engagement postings will, in fact,



**Table 2**  
Hashtags Categories with number of unique posts extracted.

Hashtags Categories	Hashtags	No. of Unique Posts	
3R	Popular hashtags: #zerowastemalaysia/ #zerowasteMY	586	
	#kitarsemula (recycle)	193	
	#recyclemalaysia	55	
	Other hashtags: #bersamakitazerowaste (together we zero waste); #jomzerowaste (let's zero waste); #litterfreemalaysia; #ecofriendlymalaysia; #mesraalam (eco-friendly); #jomrecycle (let's recycle); #upcyclemalaysia; #gogreenmalaysia; #reusemalaysia	97	
	Plastic waste	Popular hashtags: #taknakstraw (no to straw)	205
		Other hashtags: #taknakplastik (no to plastic); #plasticfreemalaysia	40
		Fabric	Popular hashtag: #klothcares
	Other hashtag: #theswapproject		3
	Food waste	#hargaimakananelakpembaziran (#valuefoodnowaste); #ramadantanpapembaziran (Ramadan without waste); #zerowasteramadhan; #foodwasteMY/ #foodwastemalaysia; #compostingmalaysia/ #compostmalaysia	83
		Voluntary projects	Popular hashtag: #trashheromalaysia
Other hashtag: #TheLostFoodProject; #foodbankMY; #mysavefood; #unm_seen; #belinothingproject (buy nothing project)			71
Businesses initiatives			Popular hashtag: #biglittlthings
	Other hashtag: #milosayangbumi (Milo love Earth); #sampahmenyampah (?); #kitarefill (we refill)	36	
Agencies campaigns	#jpspn; #PengasinganSisaDiPunca (waste separation at source)	35	
	<b>Total</b>	<b>1723</b>	



**Fig. 2.** Publishing year of Instagram high engagement posts recorded.

indirectly contribute to increasing followers for that specific user account. As a result, it is easier for a later post published by the same user to garner greater engagement. Gleason (2013) claimed that learning on a single news-related issue, despite having a certain timeline, was maintained by that specific hashtag and reading intertextually. Meanwhile, the decline in the number of included posts in 2022, which was 327 posts, may be due to Malaysians spending slightly less time on social media in 2022, which was 2 h and 47 min, compared to 3 h and 2 min in 2021 (Kemp, 2022). Furthermore, these data do not represent the entire number of posts produced each year.

Since the start of Instagram postings on zero waste in Malaysia, 94.3% of the high engagement postings came from private sector and

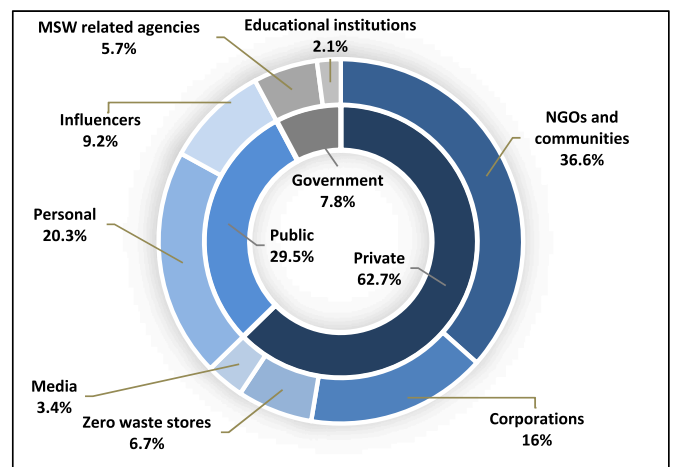
public accounts, instead of government-related agencies and institutions (7.8%). This demonstrates the significant influence of the private sector, particularly non-governmental organizations (NGOs), zero waste stores, media and other corporations such as L'Occitane and Milo, in cultivating zero waste in Malaysia. From the 566 user accounts sampled, NGOs and communities accounts were the most prevalent (36.6%) in uploading zero waste-related high engagement Instagram content. Next is personal accounts (20.3%) followed by corporations and firms (16.0%).

This is in line with zero waste advocates' belief in the capability of individual networks to bring a deep sense of collaborative goal and action, as well as mobilise new members via social media. These achievements result from discussion and engagement within its online communities to foster sustainable lifestyles (Spiteri, 2021). Awareness has been spread collectively through postings, sharing, and informal gatherings of its like-minded members and followers, proving that social media definitely has a significant impact on influencing people's minds.

This finding too, showed that the zero waste concept in Malaysia appears to be gaining the interest from the public upon reaching the decision-makers. Unlike the top-to-bottom zero-waste approach practiced in developed nations, where it has drawn more attention from grassroots associations and policymakers. As example, a flagship policy in constructing a 'zero-waste city' in China (Gong et al., 2022). Ironically, policies to minimize and avoid waste can alter individuals' and communities' behavior, as policymakers are accountable for managing both the disposal and impact of the waste (Irani et al., 2018).

It was also found that 9 personal accounts owned by ordinary people uploaded at least 5 high engagement posts, accounting for 124 (7.2%) of the posts. Although these individuals are not yet influencers, they actively promote their zero waste practices and develop into lifestyle experts who are referred to as lifestyle influencers (Ramjaun, 2021). Posts held by public accounts made up 29.5% of all posts, with 9.2% published by influencers such as public figures and Instafamous who have at least 10,000 followers. Influencers on social media were characterised as people who have many followers and are capable of influencing others due to their credibility and authenticity (Spiteri, 2021). Fig. 3 shows the contribution percentage of high engagement posts based on account type.

Since 2018, MSW-related government agencies and national private concessionaires have gained engagement from their awareness postings, especially from their 99 high engagement posts. Meanwhile, educational institutions' posts focused primarily on voluntary recycling programmes held in those schools, along with some knowledge sharing by the university's environmental clubs to spread public awareness. This great effort is a crucial step in instilling waste reduction and recycling practices since waste generated by students majorly are food waste and



**Fig. 3.** Contribution percentage of high engagement posts according to account types.

recyclables (Zulkifli et al., 2019).

Although the media only uploaded 3.4% of posts to promote zero waste lifestyles, informal learning is nevertheless made possible by the contents created by other users' accounts. The prominence of user-generated content, in which posts or media are made independently by users rather than by mainstream or corporate media, adds plenty more voices to the discourse and allows new possibilities for engagement (Gleason, 2013). Personal accounts' experience and knowledge sharing in Instagram postings demonstrate that people are well aware that individual actions may have impact (Ellison et al., 2019) on waste management overall. Whether they are 'consumer learners' on a zero waste journey or 'consumer activists' serving an educating and motivating role in the social media community, the collective power will produce a more sustainable environment (Ramjaun, 2021).

Most of the media used in high engagement posts are in the form of carousel (36.4%), while video-typed content received the most likes. Yet, the number of likes merely indicates how far the posting has reached and is not a significant element for shaping user decisions or expressing their views (Maulidini and Sumarwan, 2022). Carousels, which are postings that comprise multiple pictures or videos, were discovered to be the most popular type of content on Instagram in 2021 and 2022, reaching 2325 users on average (Dixon, 2023). Interestingly, considering the fact that Malay is Malaysia's national language, 78.2% of the high engagement posts were written in English. Malay (20.9%), Chinese (0.8%), and Tamil (0.1%) were the remaining languages used. All English postings were formally written using standard language with minimal jargons and abbreviations. Fig. 4 depicts two pie charts illustrating the percentage of high engagement posts by media type and language.

### 3.2. Sentiment analysis

The sentiment analysis method was used to analyze 1500 comments from 137 high engagement posts. TextBlob was used to perform sentiment analysis on each comment by providing polarity and subjectivity scores. The polarity score reflects the emotions or attitudes expressed in the comments, ranging from -1.0 to 1.0, with -1.0 representing negative sentiment, 0 representing neutral feeling, and 1.0 representing positive sentiment. Meanwhile, the subjectivity score represents the level of knowledge displayed in the comments on a scale of 0.0 to 1.0, with 0.0 being objective and 1.0 being subjective. Table 3 and Table 4 illustrate examples of comments with varying degrees of polarity and subjectivity

In response to the polarity results of sentiment analysis presented in Fig. 5, the majority of the comments exhibited positive sentiments with scores ranging from 0.1 to 1.0, with a percentage of 41.3% specifically

showing positive sentiments with scores ranging from 0.1 to 0.5. Only 7.7% and 33.9% of the comments were negative or neutral, respectively, with no comments scoring less than -0.7. These data suggest that the public in Malaysia has a fairly positive attitude towards the zero waste lifestyle. It is clear from the comments that Malaysians are very supportive for any initiative that aimed to achieve zero waste, whether they originate from the private sector, such as Kloth's fabric recycling programs, or from the individuals' efforts to carry their own reusable straws. For example, the Kloth's Instagram post on fabric recycling guidelines received 630 likes and 145 comments on its own.

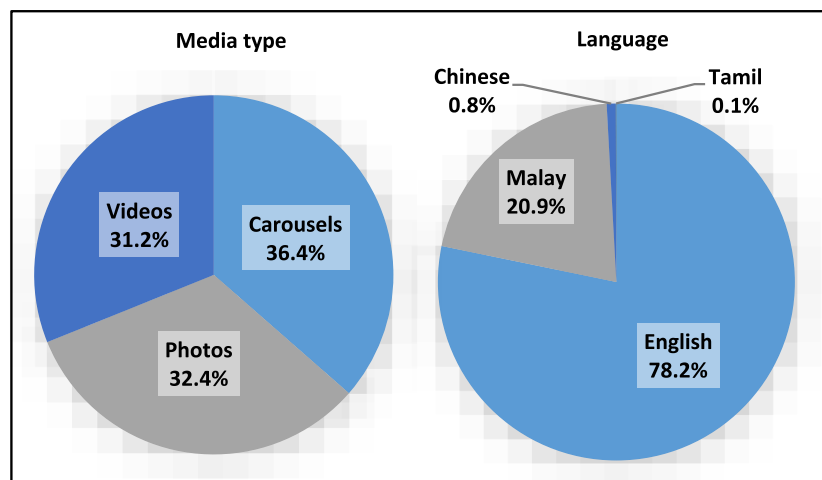
As more individuals turn to social media to share their experiences, voice their thoughts and viewpoints, and seek solutions (Guo et al., 2020), it opens up new opportunities for social involvement because people are not only effortlessly sharing information but are also actively benefiting from it (Gleason, 2013). As a consequence, the public constantly and freely expresses their views, opinions, and thoughts about the zero waste practice and information sharing on adverse environmental effects (Mishra and Singh, 2018) through comments and reactions. Indeed, changes in perceptions are a critical first step in influencing behavioural change towards zero waste (Ellison et al., 2019), and this is clearly demonstrated by individual Malaysians' postings and comments.

On the other hand, Fig. 6 depicts the number of comments received for each subjectivity score. It was found that comments with a subjectivity score of 0.0 to 0.2 account for 36.1% of all comments, while comments with a value of 0.8 to 1.0 account for only 17.3%. This indicates that more of the comments examined in this study are objective

**Table 3**

Examples of comments with different polarity scores.

Polarity	Negative Sentiment	Neutral	Positive Sentiment
Score	-0.1 to -1.0	0	0.1 to 1.0
Comments	i) Where are all the people? We should know this video so that we all know how to take care of the earth well.	i) Can I put all my used clothes in plastic? ii) Always bring a tupperware with you and bring leftovers to feed my dog at home.	i) I'm in Ipoh. Where is the active recycling centre so that the residents of Ipoh can easily find it? ii) I also started this since 3-4 months ago. Feel happy knowing we are no longer included in the statistics of 'disposing straw'.



**Fig. 4.** Percentage of high engagement posts by media type and language.

**Table 4**  
Examples of comments with different subjectivity scores.

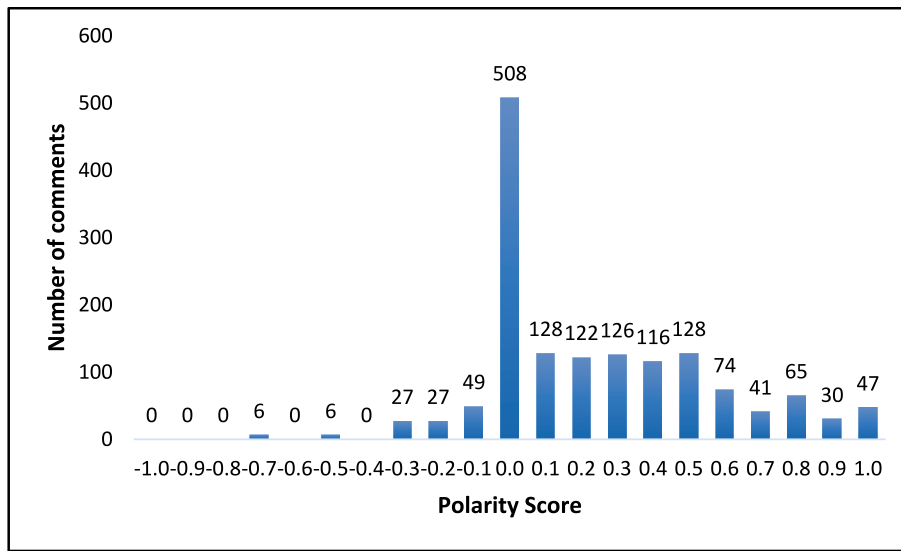
Subjectivity	Objective Sentiment	Subjective Sentiment
<b>Score</b>	0.0 to 0.5	0.6 to 1.0
<b>Comments</b>	i) How about laptop power adapter? Can that be recycled too? ii) Always finish your food and/or leftovers.	i) Yes!!! Finally found a place for bubble wraps. ii) Been wondering why glass at Germany have its own value while no value in Malaysia ... Can we recycle glass for the crushing sand?

and knowledge-based rather than subjective or opinion-based. This was obvious from the 19 constructive comments on an Instagram post on the Parliament’s speech about establishing a return deposit scheme to encourage recycling. It shows that social media may enable the public to openly express their opinion and engage spontaneously to any governmental policy communication, proving that social data can also be used to evaluate public satisfaction regarding policy construction (Gleason, 2013; Gong et al., 2022). Several comments in the post mentioned

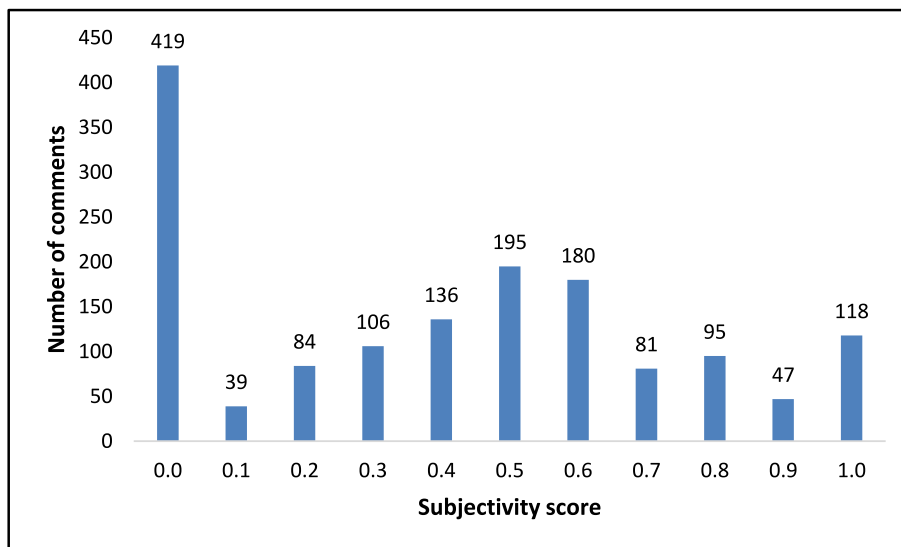
existing initiatives in developed countries, while others offered suggestions to ensure the successful execution of this recycling programme. Even though the remaining comments simply show support and compliments, encouragement and praise can be essential in promoting persistent pro-environmental actions (Spiteri, 2021). In the community, zero waste is viewed as a long-term objective rather than an instant extreme action (Ramjaun, 2021). Nonetheless, this finding taken from responses from Malaysia’s zero waste communities should not be interpreted as representing the whole population’s awareness level.

The text of each post’s caption was examined to find out more about Malaysians’ zero-waste practices. Table 5 summarizes and tabulates these practices based on the 3Rs models.

The campaign to discourage the usage of single-use plastic, such as #taknakstraw (no to straw), continues, although the plastic straw ban announced in 2019 is no longer in effect. The MYR 0.20 fee on plastic bags, which came into effect in 2022, intensified the drive to refuse single-use plastics even more. These initiatives are crucial since Malaysia has been tracking global patterns in plastic waste generation since 2017 (Chen et al., 2021). Mahmood and Lim (2021) revealed that



**Fig. 5.** Number of comments for each polarity score, where -0.1 to -1.0 represents negative sentiment, 0.0 represents neutral, and 0.1 to 1.0 represents positive sentiment.



**Fig. 6.** Number of comments for each subjectivity score, with 0.0 being objective and 1.0 being subjective.

**Table 5**  
3Rs practices observed among the online zero waste communities.

Reduce	Reuse	Recycle
reduce meal portion	bring own straws, bag and containers	100% recyclables packaging design
rescue food waste to feed families in need	reusables sanitarries (menstrual cup, cotton pad)	fabric recycling
composting (bokashi, BSFL, chicken composter)	preloved market or cloth swap	beauty empties recycling
no single use plastics	refillable detergents and toiletries	recycling station or drop off
avoid deliveries and online purchases	upcycle fabrics and used items	recyclables collection during beach clean up

only 24% of the plastics were recycled in 2019 and that 1 million tonnes of plastic are thrown away annually. In fact, some of the voluntary beach and forest clean-up programs conducted by the NGOs such as Trash Hero Malaysia and EcoQueen showed a worrying amount of plastic waste that had not been adequately managed and had been dumped into the natural environment.

Additionally, more individuals posted eye-catching Instagram photos capturing their experience using fancy reusable bags and straws, which indirectly attracted more people to adopt the ‘trend’. This shows that Instagram displays as a platform for celebrating one’s lifestyle through creative self-expression via visual and written content. It is also a valuable tool for gaining a deeper understanding of present or new practices and habits within specific communities (Ramjaun, 2021). Aside from Kloth’s unwanted fabric collection drive (#klothcares) and L’Occitane beauty empties recycling programs (#biglittletthings), other high engagement posts in 2023 include food waste reduction campaigns and composting. By instilling awareness and behavioral changes through such postings, the food waste problem, which is mainly caused by lack of planning, shopping routine, moral attitudes, subjective norms, and packaging (Ab Aziz et al., 2022; Bollani et al., 2019; Irani et al., 2018), may be overcome.

The role of zero waste and bulk stores too, has undeniably enhanced Malaysians’ knowledge of the benefits of zero waste practices. Zero waste shops have developed a small zero waste community that supports each other by providing refillable options for their customers to buy detergents and other home needs, selling green products, and providing drop off points for recyclables. Other studies have indicated that this kind of public-private partnership plays an important role in numerous fields (Papadopoulos et al., 2017). There was also extensive sharing of everyday routines of their zero waste journey by public accounts, such as bringing own bag and adopting sustainable consumption.

Meanwhile, there were plenty of comments that were inquiry-based, such as inquiring how and where to recycle. All of these posts and comments documented not only experience sharing but also information gathering, which fits the nature of informal learning. Ramjaun (2021) describes these individuals as “consumer learners,” and their biggest motivation is to master more zero waste practices in order to live a more sustainable lifestyle. The postings or comments in online zero waste communities also tend to encourage a learning and informative approach. These practices shared on Instagram demonstrate that social media has confirmed to provides an infinite number of opportunities for all parties to promote a zero waste lifestyle and raise awareness of responsible and sustainable waste management.

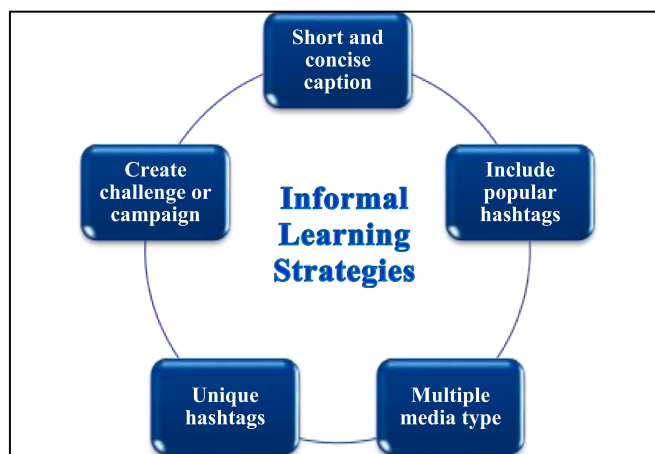
### 3.3. Informal learning strategies

The development of informal learning strategies on social media was guided by the descriptive data from the study’s high engagement posts and previous studies. Highly engaged social media posting, as demonstrated by how people decide to post (Dixon, 2023), is critical to ensure that informal learning reaches a wider range of community members.

Popular hashtags such as #zerowastemalaysia should be included in the informal learning post’s contents to boost the effectiveness of zero waste information sharing and transfer in any intended Instagram post. These well-established hashtags make these uploads more accessible and increases the chances to receive more reactions from people outside of the networks (Maulidini and Sumarwan, 2022). Furthermore, in order to achieve effective informal learning, an intriguing caption should contain two to three details, establish a sense of responsibility and empathy for readers, and have the ability to affect the audience’s behaviour (Maulidini and Sumarwan, 2022). Most essential, the caption should be kept brief and concise. According to this study, 84.6% of high engagement posts with the most likes and hundreds of comments have less than 120 words.

Instagram functions best as a means of communication and marketing when combined with the posting strategies outlined above, as well as multiple media published within the posts (Maulidini and Sumarwan, 2022), such as a combination of photos or videos. Because of the highly advanced and rapid data expansion of social media, it is also suggested for a virtual campaign or challenge to be created with specific hashtags. Informal learning can be conducted collaboratively by including standardised hashtags to address any campaign or issue. For example, the previous #bersamakitazerowaste (together we zero waste), which were launched by ZWM for their 30 Days Zero Waste Challenge, accumulated 3541 posts in a short amount of time. These challenges with the efforts to popularise such inspiring hashtags are found to be a good strategy to further motivate or promote zero waste lifestyles (Ramjaun, 2021). Campaigns for consumer education are powerful in improving consumers’ habits in addition to being low cost and easy to implement (Ellison et al., 2019). Fig. 7 depicts a summary of the proposed informal learning strategies.

The strategies proposed are sufficiently broad and are not confined to informal learning. These approaches are also applicable to different social domains and goals, such as identifying the underlying causes of improper waste management in the community as well as conveying effective policy communication (Gong et al., 2022). They are also applicable to every stakeholder. Although effective and substantial efforts to combat climate change and promote waste reduction must originate from governmental and corporate authorities (Spiteri, 2021), the citizens, as social promoters, may also give greater attention to engage their target audiences (Maulidini and Sumarwan, 2022). All stakeholders, whether government agencies, the commercial sector, or the general public, must work together to promote waste reduction and environmental protection. These strategies will facilitate every stakeholder to enhance their synergy in terms of knowledge sharing (Mishra and Singh, 2018) and promote active learning to the public through



**Fig. 7.** Proposed informal learning strategies on solid waste management in social media.



comments and zero waste practices they shared. Indeed, passive education may be ineffective in reducing waste among the consumers (Ellison et al., 2019).

#### 4. Conclusion

This study contributes to the literature on sentiment analysis and zero waste by integrating social media analytics with informal learning. By using the obtained findings from the descriptive statistics, strategies for publishing more constructive knowledge sharing and impactful social media campaigns were proposed. This serves as reference information for policymakers and organizations by offering practical and cost-effective solutions to further encourage public participation in waste management. The sentiment analysis result confirms that the public knowledge and attitude concerning zero waste lifestyle in Malaysia are fairly positive and objective-oriented. The zero waste practices shared among the online users too further contributes insights that collective individual efforts in the online zero waste communities begin to influence social change in Malaysia. Most importantly, this study recommends simplified big data analytics approaches through easy-to-use tools such as Phantombuster and TextBlob to analyze the abundant social media data to inform public knowledge, awareness, and practice.

It is recommended that future research on social media analytics include important keywords in addition to hashtags to allow for a more in-depth study. This is because there are high engagement posts discovered in this study that did not include any of the relevant hashtags recorded, which had to be disregarded despite having a significant impact. Additionally, a better machine learning model than TextBlob is recommended for complex sentiment analysis in future research to obtain higher results accuracy. When data is available, it would also be interesting to study public perspectives by considering cross-platform data, such as from Facebook and Twitter, to obtain better insights. It is envisaged that by fully utilizing social media to educate the public, the objective of building a zero waste nation will be accomplished.

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#### CRedit authorship contribution statement

**Nur Suhaila Zulkifli:** Conceptualization, Formal analysis, Investigation, Methodology, Resources, Software, Visualization, Writing – original draft. **Latifah Abd Manaf:** Conceptualization, Methodology, Supervision, Validation, Writing – review & editing.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Data availability

Data will be made available on request.

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