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RESEARCH ARTICLE

Twitter is garbage: A Thick Big Data exploration of #zerowaste hashtag on Twitter in relation to packaging and food packaging materials

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Zero Waste (ZW) is a relatively new concept of waste reduction, which encourages life cycle thinking in the design of new products and services. Today ZW is becoming a lifestyle trend and social media amplifies this trend and helps to propagate the movement. The popularisation of the ZW concept through social media can be attributed to Bea Johnson, author of a bestselling book on ZW living. Many tips on how to achieve ZW living in Bea Johnson's book refer to food packaging and packaging materials, and literature shows that global consumers are increasingly concerned about the negative environmental impacts of packaging waste. Given the popularity of ZW lifestyle in social media, this study explores the ZW trend as reported by users of the popular social media platform Twitter through the lens of Bea Johnson's ZW living model, taking into consideration the public concern on packaging and packaging materials. For the purposes of this paper, Twitter discourse on ZW is used to draw conclusions on the popular understanding of its impact and effects. This paper uses Thick Big Data study of the collected 124,077 tweets with #zerowaste hashtag. In the study, it was found that majority of popular tweets with #zerowaste hashtag refer to packaging and food packaging. The majority of tweets focused on plastics, and the sentiment of this packaging material was negative. Other packaging materials found in #zerowaste hashtag tweets include paper, glass and metal, and the sentiment for those materials is gradually more positive.

KEYWORDS
Big Data, food packaging, packaging, sentiment analysis, social media, Twitter, zero waste

1 | INTRODUCTION

Zero Waste (ZW) is a relatively new concept of waste reduction, which encourages life cycle thinking in the design of new products and services. ZW is often described as a visionary and alternative waste management system and is one of the most studied and controversial topics in the past decade in the field of waste management.[1,2] ZW was defined by the internationally recognised online source for ZW standards, policies and best practices for communities and businesses—the Zero Waste International Alliance as 'the conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health'.[3] The approach is to inspire the reshaping of the resource supply chain away from the old so-called linear model, so that entire products or by-product materials are reused or recycled.[4] This shift from the current make-use-dispose mentality of product consumption is required to move to the ideal of a 'Circular Economy', where the world's resources are kept in use for as long as possible and their value is retained.[5] Currently, many ZW

programmes, policies and strategies, often linked to 'Circular Economy' and 'Sustainable Development', are implemented in many places around the globe.[2,6,7]

However, the ZW concept is not only limited to more technical areas of waste management. ZW is becoming a lifestyle trend across Europe and beyond. Social media amplifies this trend and helps to propagate the movement.[8] Today, ZW is a keyword that is universally recognised across languages and translations.[9] It can be argued that the ZW concept is at the intersection of the two different topics: the ZW management practices developed on the organisation level and the environmentally friendly behaviour on the individual or household level.[8]

The popularisation of the ZW concept through social media can be attributed to Bea Johnson, an affluent California-based French native, who decided to use this term to describe her initiatives to live a life by causing as little waste as possible.[10] In 2013, Bea Johnson released a book titled 'Zero Waste Home: The Ultimate Guide to Simplifying Your Life by Reducing Your Waste', where she introduced the '5 R's' model of ZW living. Her 5 R model includes five actions in the form of inverted pyramid, from most to least important one these include: refuse, reduce, reuse, recycle and rot (or compost),[11] presented in Figure 1. This 5 R model was adopted from many 'Number' R waste hierarchy strategies that are functioning in literature and are used by industries, NGO's and even as legislation on local and national levels, such as 3 R (reduce, reuse, recycle) or even 6 R (reconsider, reuse, reduce, recycle, recover and retain).[12,13]

Many tips on how to achieve ZW living in Bea Johnson's book refer to packaging (including a very important subset of food packaging) and how to apply the 5 R model to packaging and packaging materials. Literature shows that global consumers are increasingly concerned about the negative environmental impacts of packaging waste.[14] The particular case of packaging waste was emphasised due to a number of issues, including the environmental impacts of landfilling and the possibility of using packaging waste as a resource (avoiding the consumption of raw material).[15] Special focus has been given to plastic packaging and plastic packaging waste, but other packaging materials such as bioplastics (a subset of plastics that are either or both biodegradable or are produced from renewable resources), paper, glass and metal are also investigated.[16–20]

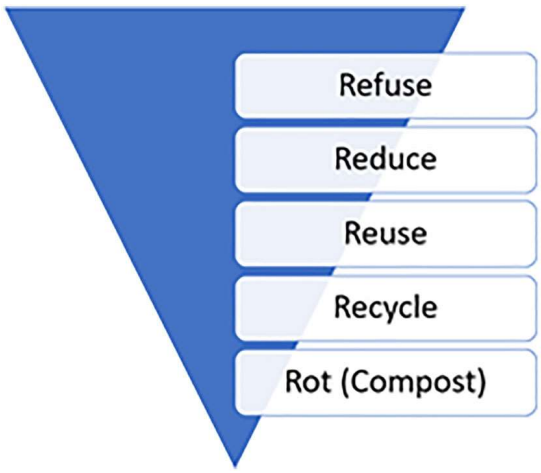

FIGURE 1 The 5 R's of Zero Waste (ZW) living (adopted from Zero Waste Home: The Ultimate Guide to Simplifying your Life by Reducing your Waste by Bea Johnson)

Given the popularity of ZW lifestyle in social media,[8,10,21,22] in this study we explore the ZW trend as reported by users of the popular social media platform Twitter through the lens of Bea Johnson's 5 R model, taking into consideration the public concern on packaging (including food packaging) and packaging materials. Twitter is a microblogging social media platform with over 320 million active users. It is a powerful public discourse space[23]: in contrast to other social media, it is principally focused on making relatively short, fully public comments in text format. While in some countries it is used by large parts of the population, in others it is predominantly used by politicians, activists and celebrities. In some topics, it can be filled with misinformation.[24] Still, it is a highly interesting forum of ideas exchange, reflecting the opinion pulse check in many ways: Twitter discourse analysis is useful in understanding different social phenomena.[25–27] It can be even used as a useful election prediction tool[28] or new venture success.[29]

2 | MATERIALS AND METHODS

2.1 | Data collection

In order to investigate the ZW lifestyle on Twitter through the lens of Bea Johnson's 5 R model, we used a Python GetOldTweets3 script to scrape 124,077 tweets with #zerowaste hashtag. For the purpose of sentiment analysis, we used TextBlob script.

2.2 | Methodology

We decided to conduct a Thick Big Data study of the collected material.[30] Thick Big Data is a novel, mixed method of research, relying on computational analysis of large datasets combined with highly qualitative content analysis.

First, we examined all scraped tweets according to Bea Johnson's 5 R's model of ZW living by performing a keyword occurrences search of 5 R's (refuse, reduce, reuse, recycle, rot/compost). We then grouped all collected tweets containing hashtag #zerowaste into five principal packaging materials according to literature (plastic, bioplastic, paper, glass and metal).[31–33] This was achieved by filtering the Twitter data with mentioned packaging materials keywords. The resulting five datasets were then analysed for sentiment (polarity). During this procedure, we observed that sentiment results have rather substantial confidence intervals and the results for all five packaging groups are rather uniform. Upon closer qualitative investigation of this issue, we discovered that many of tweets with #zerowaste contain metadata such as videos, hyperlinks and pictures, which provide significant context to the sentiment of messages. In order to resolve this issue, we

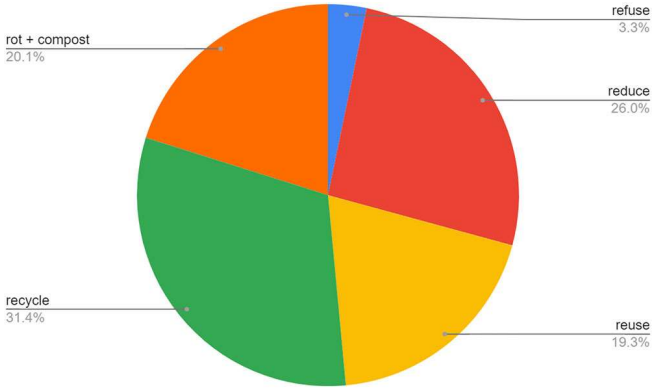

FIGURE 2 Share of 5 R rules of Zero Waste (ZW) living occurrences in all collected tweets with #zerowaste hashtag

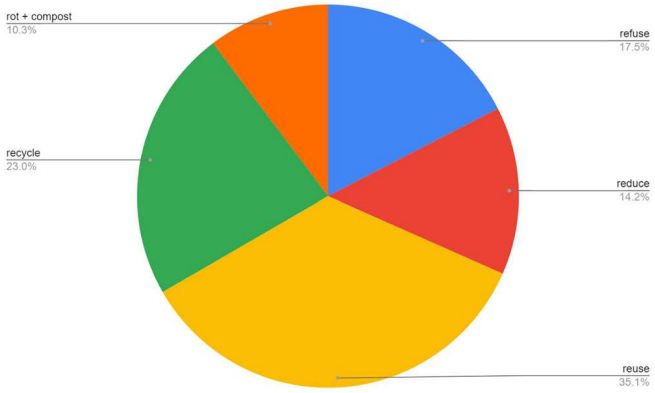

FIGURE 3 Share of 5 R rules of Zero Waste (ZW) living occurrences in most popular tweets with #zerowaste hashtag in five investigated packaging material categories

decided that a qualitative analysis of all five datasets has to be performed. We ranked the five packaging materials datasets according to their popularity (the popularity of tweets is measured as a sum of replies, retweets and favourites) and selected 100 of the most popular tweets for each packaging material category for further analysis. We first created qualitative coding criteria that investigated whether the tweet referred directly or indirectly (via context of the tweet, embedded image, video or the content of the included hyperlink) to packaging, and what proportion of those tweets referred to food packaging specifically. Then using the same criteria and we investigated whether the tweet mentioned directly or indirectly Bea Johnson's 5 R's of ZW Living (refuse, reduce, reuse, recycle, rot/compost). This allowed us to explore a broad picture of how Twitter users understand the ZW lifestyle concept according to 5 R's in relation to five investigated packaging materials.

In addition to the coding categories, we also investigated the sentiment of the full context of the tweets in relation to the five selected food packaging materials in a standard scale of sentiment polarity (positive, neutral, negative). This allowed us to discover how each of the five packaging materials is perceived by the Twitter community.

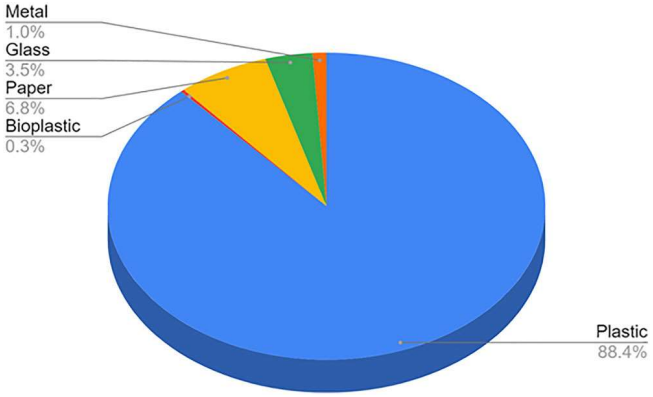

FIGURE 4 Share of tweets with #zerowaste hashtag containing five investigated packaging materials

3 | RESULTS AND DISCUSSION

3.1 | Keyword occurrences in full dataset and taking into account the popularity of tweets

Figure 2 presents the share of occurrences of Bea Johnson's 5 R's keywords in all tweets with #zerowaste hashtag, while Figure 3 presents the same share of occurrences within the most popular tweets in investigated five packaging material groups. Results for the total population of #zerowaste tweets show that 'Recycle' has the biggest share with 31.4%, followed by 'Reduce', 'Rot/Compost' and 'Reuse'. It is interesting that 'Refuse'—the most important aspect of 5 R's inverted pyramid, has the smallest share of occurrences, with only 3.3%. This result signifies that as a whole, Twitter community using #zerowaste hashtag does not understand the waste hierarchy according to the 5 R model, contrary to the popularity of this model and the popularity of this ZW model in social media. It is also interesting to note, the lead role of 'Recycle' is concurrent with the recognition of recycling as a principle strategy of attaining ZW, despite its low priority in the hierarchy and ZW community claims that waste reduction combined with increase in material productivity are of even more importance than recycling.[12,13] On the other hand, when taking into account the popularity of tweets in all respective packaging materials categories we can observe that the understanding of the hierarchy is slightly more balanced for all five elements of the 5 R model. In this analysis, the biggest share belongs to the 'Reuse' category with 35.1%, followed by 'Recycle', 'Refuse', 'Reduce' and 'Rot/Compost'. This result might signify that understanding of the 5 R model is correlated with Twitter community engagement and will be investigated further.

Figure 4 shows the share of tweets containing keywords based on investigated principal packaging materials. Paramount share of tweets concerning plastics confirm findings of other authors that the environmental issues related to plastic use are also predominant topics of discussions associated with the #zerowaste hashtag.[8,10,34]

3.2 | Keyword occurrences according to packaging materials

3.2.1 | Plastics

Plastics are an immense family of unique and versatile materials that have been used for packaging solutions since their discovery.[35] Unfortunately, the excessive production and consumption of plastic has serious consequences on the environment and human health. The reduction of plastic has therefore become a major global challenge.[36] There is growing attention worldwide towards reducing the use of disposable plastics and transitioning towards a circular economy for plastics.[37] Plastic packaging is a top waste management and recycling priority, particularly for single-use plastic. Only 40% of Europe's 14.8 million tons of annual plastic waste is recycled.[38] As almost 40% of all plastics produced is used for packaging applications.[39] Figure 5 presents the findings of qualitative analysis of first 100 most popular tweets with #ZeroWaste hashtag that mentions plastics. Out of 100 tweets, 70 mention plastic as a packaging material and out of those tweets 54 refer to plastic as a food packaging material. The most popular 5 R's strategy for plastics from this dataset were 'Reuse' and 'Refuse', followed by 'Reduce', 'Recycle' and finally 'Rot/Compost' (which is considered a problematic waste management option for the majority of traditional plastics).[40]

High number of mentions of primary 5 R's strategy of 'Refuse' relative to low overall share of this keyword in all investigated tweets and other packaging materials categories, confirm previously reported focus on plastics with regard to ZW policies.

Qualitative sentiment analysis of this dataset, in Figure 6, showed that 87% of most popular tweets with keyword #zerowaste that mentioned plastics were negative, while 7% were neutral and 6% positive. This is in line with many studies that show the public view of plastics as a serious environmental issue.[37]

Majority of positive sentiment tweets for plastics commended companies and businesses for switching to recycled plastics, neutral tweets either informed about the volume of plastics waste or downplayed the ZW movement, stressing global warming as a more significant issue. On the other hand, negative sentiment tweets had more varied topics and themes and included: promotion of ZW shops and emphasised that no single use plastics were used in food and products packaging; praised local governments and cities that imposed legislation against single use plastic products and waste, discussed statistics on scale of plastic pollution; presented 'illogical' practices concerning plastic food packaging in supermarkets (like overpackaging, or pricing of plastic packed food being lower than loose products); motivated to start the ZW lifestyle by refusing and reducing plastics; promoted choosing alternatives to plastics, including bioplastics, paper, glass and metals.

3.2.2 | Bioplastics

A promising alternative to traditional plastics are bioplastics.[41] Bioplastics are a large group of plastics that are defined as bio-based, biodegradable or both. They have the same or similar properties as conventional plastics but offer additional benefits, such as a reduced carbon footprint, better functionalities or additional waste management options, such as organic recycling (defined by the EU Packaging and Packaging Waste Directive 94/62/EC as the aerobic treatment (industrial composting) or anaerobic treatment (biogasification) of packaging waste.).[42–44] On the other hand bioplastics as new and innovative packaging material group can be very confusing for consumers, especially regarding their end-of-life. Most commonly quoted issues with bioplastic packaging from the perspective of consumers are misunderstanding of terms (what is biodegradable, compostable, home-compostable, renewable etc.), misuse of those terms by manufacturers, which willingly or unwillingly lead to green-washing marketing practices, lack of common standards to assure, test and certify the properties of bioplastics and their similarity to traditional plastics and the possibility that they will be disposed in traditional plastic waste (which can lead to problems in recycling, with compostable

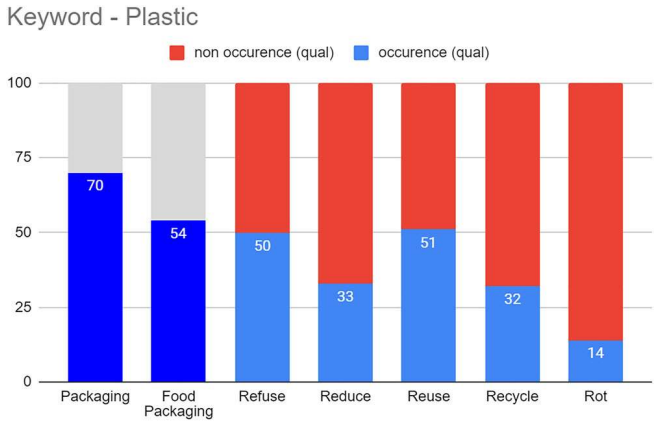

FIGURE 5 Mention of packaging, food packaging and occurrence of 5 R strategies of Zero Waste (ZW) living in tweets with #zerowaste hashtag that mentioned plastics according to qualitative analysis of 100 most popular tweets from the category

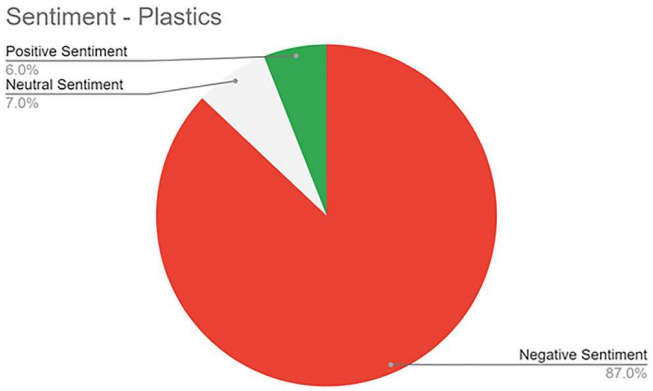

FIGURE 6 Sentiment of tweets with #zerowaste hashtag that mentioned plastics according to qualitative analysis of 100 most popular tweets from the category

bioplastics).[45,46] Many of those issues are actually reported in tweets about bioplastics and bioplastic packaging.

The niche market share of bioplastics (which represent about 1% of the more than 368 million tonnes of plastic produced annually[47]), is represented in the #zerowaste hashtag on Twitter, with only 0.3% of all tweets referencing this material group (Figure 3). In fact, only 83 of the considered tweets mentioned bioplastics as material.

Figure 7 presents the findings of qualitative analysis of 83 most popular tweets with #zerowaste hashtag that mention bioplastics. Forty-eight of those referenced bioplastic as a packaging material and out of those tweets 38 refer to bioplastic as a food packaging material. The most popular 5 R's strategy for bioplastics from this dataset were 'Recycle' and 'Rot'. Recycling of biobased plastics is a complex issue, as certain types of materials from this family can be recycled in the traditional, material sense, while others can biodegrade and be composted (often referred to 'organic recycling' in certain legislation[44]). However, biodegradation is normally not aimed at recovering plastic materials or monomers to be reintroduced in the life cycle of plastic products,[43] which is also the reason why 'Rot' strategy is at the bottom of the 5 R's pyramid.

Qualitative sentiment analysis of this dataset, presented in Figure 8, showed that 56.1% of tweets had a positive sentiment, while 19.5% were negative and 24.4% were neutral. Most of the positive sentiment tweets emphasised that bioplastics are innovative materials that are more sustainable alternatives to traditional plastics and informed about new bioplastic materials that were developed (especially when they were derived from recycled resources and/or waste from other technospheres). Neutral tweets were mostly focused on the complexity of bioplastics definition and confusion about the concept of biodegradability, compostability or renewable nature of feedstock resources. Negative tweets posed questions and doubts about bioplastics as a viable ZW alternative, citing reports and literature about various issues with recycling and composting.

3.2.3 | Paper

Paper is one of the most important and universal packaging materials. Paper and cardboard have been used both as primary and secondary packaging for a wide range of foods for many years.[48] Paper is compatible with many recovery options, including compostability, and paper recycling is one of the most well-established recycling schemes applied to waste materials today. Additionally, recycled paper is widely used and is an integral part of paper and pulp production.[49] Paper is often linked with other materials, such as plastic materials and aluminium, for their good barrier properties that could be advantageously combined with paper stiffness.[50] Unfortunately, from the perspective of end-of-life those material combinations are often difficult to recover and/or recycle.[51]

Figure 9 presents the findings of qualitative analysis of 100 most popular tweets with #zerowaste hashtag that mentions paper. Over two-thirds of those tweets referenced packaging and out of those 40 tweets were about food packaging specifically. The most popular

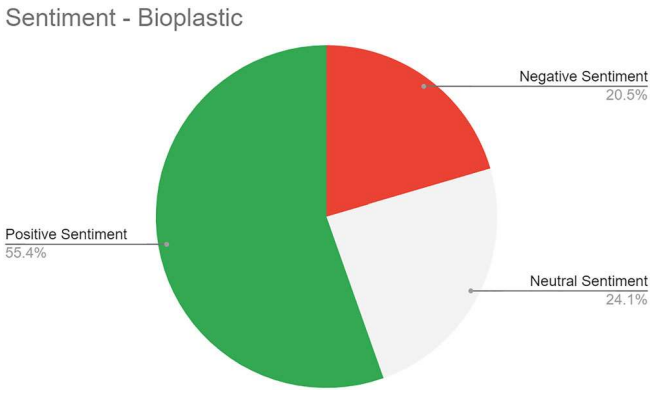

FIGURE 8 Sentiment of tweets with #zerowaste hashtag that mentioned bioplastics according to qualitative analysis of most popular tweets from the category

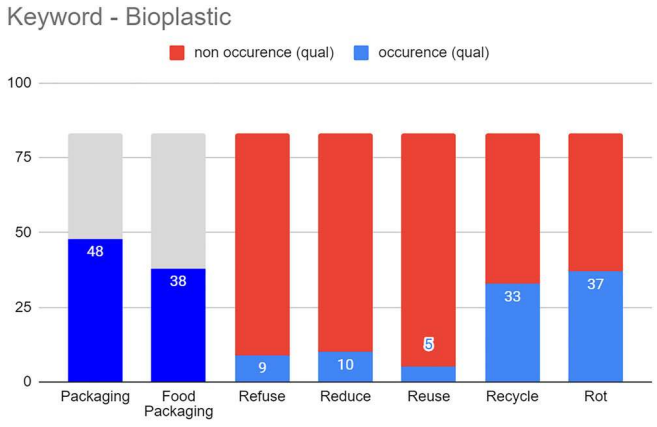

FIGURE 7 Mention of packaging, food packaging and occurrence of 5 R strategies of Zero Waste (ZW) living in tweets with #zerowaste hashtag that mentioned bioplastics according to qualitative analysis of most popular tweets from the category

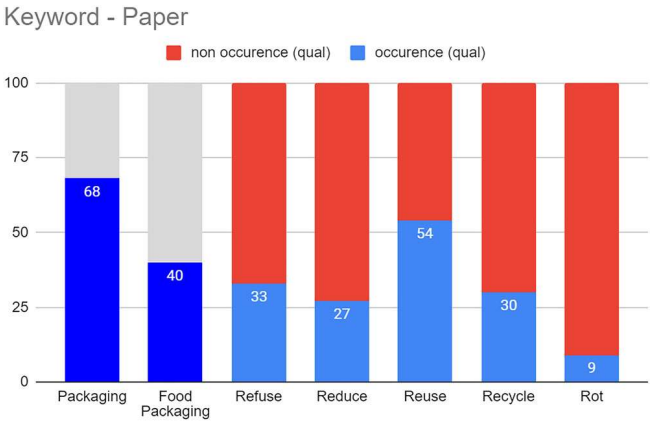

FIGURE 9 Mention of packaging, food packaging and occurrence of 5 R strategies of Zero Waste (ZW) living in tweets with #ZeroWaste hashtag that mentioned paper according to qualitative analysis of most popular tweets from the category

5 R's strategy for paper was 'Reuse', with 54 mentions, which is interesting given the fact that widely available paper packaging applications are designed for single use.[52] This result show that the Twitter community using #zerowaste hashtag is encouraging the change towards the circularity of packaging materials, which was originally designed for different applications—mostly non-food. This is also why the proportion of tweets mentioning paper as food packaging material was relatively smaller than in other packaging material groups. It is also interesting to note that 'Rot/Compost' 5 R's strategy was not widely mentioned, even though compostability is a viable route for certain paper packaging (e.g., fat contaminated food wrappers).[53]

Qualitative sentiment analysis of paper materials, presented in Figure 10, shows that 51% of tweets had a positive sentiment, while 35% were negative and 14% were neutral. Positive sentiment tweets encouraged the reuse of paper materials (e.g., using used paper as wrapping paper for presents) and using paper as an alternative for plastic packaging. Neutral tweets introduced innovative new paper packaging materials (e.g., bamboo paper) and provided hard facts about recycling. Negative tweets focused on problems with paper napkins, while 10% of tweets with negative sentiment mentioned problems with recycling of paper composite materials specifically.

3.2.4 | Glass

Glass is one of the oldest packaging materials that is still very popular today.[54] There are many advantages of glass for food packaging including inertness to most chemicals, great barrier properties, taste preservation capabilities and most importantly from the perspective of ZW, very good reusability and, in theory, infinite recyclability.[55] In fact, for glass packaging, the reuse option is very often considered before that of recycling, with numerous studies demonstrating the significant environmental benefits of reusing rather than recycling glass packaging.[56] On the other hand, disadvantages of glass as a packaging material include their higher cost in relation to other packaging alternatives and mass and breakability, which links to difficulties in transport and handling and potential health and safety issues.[57]

In our study, the qualitative analysis of 100 of the most popular #zerowaste tweets that mention glass, presented in Figure 11, show that majority of them refer to packaging applications and out of them 70 refer to food packaging (such as different types of glass containers for various beverages). The most popular 5 R's strategy was 'Reuse', with 75 mentions, followed by 'Recycle' with 29 mentions, which is in line with scientific and economic consensus about glass packaging.

Qualitative sentiment analysis of glass materials is presented in Figure 12 and shows that 78% of tweets had positive sentiment, 17% were neutral and only 5% were negative. Positive sentiment tweets praised glass for being reusable and 'endlessly' recyclable, commented on the comeback of reusable milk bottles and their curbside collection system and encouraged companies to refuse plastics and use reusable glass packaging for beverages and toiletries. Neutral tweets mostly provided information about the production process of glass, while

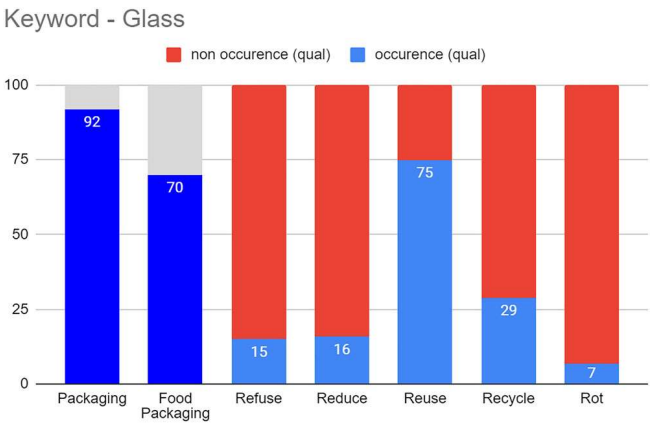

FIGURE 11 Mention of packaging, food packaging and occurrence of 5 R strategies of Zero Waste living in tweets with #ZeroWaste hashtag that mentioned glass according to qualitative analysis of most popular tweets from the category

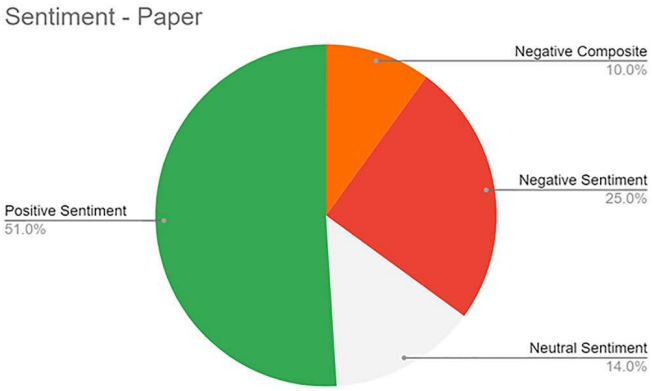

FIGURE 10 Sentiment of tweets with #zerowaste hashtag that mentioned paper according to qualitative analysis of most popular tweets from the category. This figure splits the negative sentiment of tweets that mentioned paper exclusively and tweets that focused on paper-plastic composites.

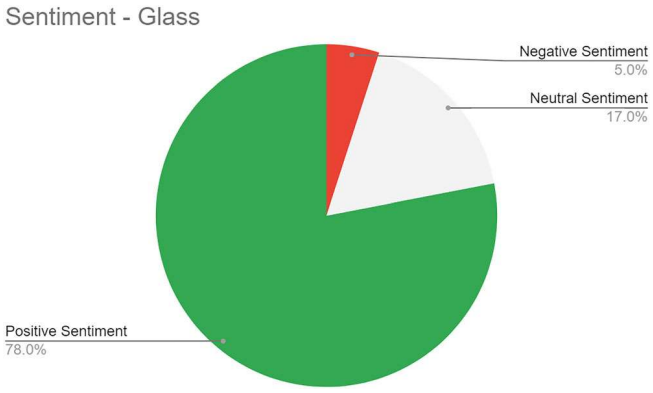

FIGURE 12 Sentiment of tweets with #zerowaste hashtag that mentioned glass according to qualitative analysis of most popular tweets from the category

negative tweets explored the problem of glass packaging ending up in landfills and composting heaps and having a very long natural decomposition time.

3.2.5 | Metal

Metal packaging encompasses a family of materials that include tin-plate, steel and aluminium. Metal packaging comes in many forms, including cans, trays, jars, bottles and closures. Metal packaging is used widely for food application due to its airtightness, high mechanical resistance and excellent barrier properties.[58,59] However, metal packaging is not inert, and therefore it is very important that the product packed and the container internal surfaces are compatible with one another so that no unwanted or uncontrollable chemical reactions take place between the two.[60] Metal packaging is also widely recyclable due to its density and magnetic properties, which help in easier segregation.[59]

Qualitative analysis of 100 of the most popular #zerowaste tweets that mention metals is presented in Figure 13. The figure shows that only half of the tweets mentioned metal as a packaging material and 44 were referring to food packaging specifically However, out of the other half, 19 tweets focused on reusable metal straws. While technically straws are not considered to be packaging according to most legal definitions, they are products very much associated with packaging, food packaging and the packaging industry. The 5 R's strategy mostly associated with metal was, similarly to glass, reuse and recycle.

Qualitative sentiment analysis of metal materials, shown in Figure 14, depicts that 77% of all tweets had positive sentiment, 21% were neutral, while only 2% were negative. The themes explored in the positive sentiment tweets focused on promotion of reusable metal containers and bottles for food and cosmetics and glass containers with metal cups and praise for reusable metal straws. Neutral tweets were mostly about the collection strategies for metal waste and recyclability of metal scrap, while two negative tweets were about the need to refuse all packaging regardless of the material and environmental problems of composite materials with metals.

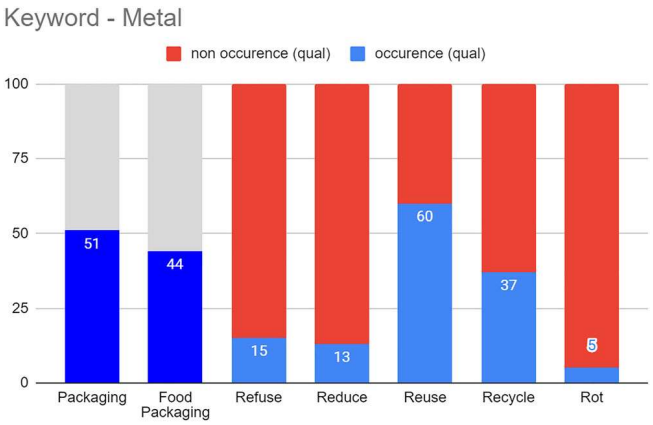

FIGURE 13 Mention of packaging, food packaging and occurrence of 5 R strategies of Zero Waste living in tweets with #ZeroWaste hashtag that mentioned metal according to qualitative analysis of most popular tweets from the category

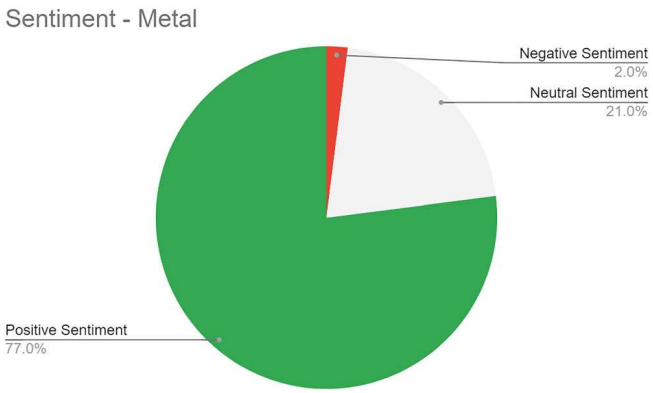

FIGURE 14 Sentiment of tweets with #zerowaste hashtag that mentioned metal according to qualitative analysis of most popular tweets from the category

3.3 | Limitations

Novel big data research focused on keyword analysis is full of methodological limitations. One of the most prominent one is that all analysed tweets were written in English language. Even though English is the most popular language used on Twitter (with share of 31.8% in 2018), the majority of tweets (68%) are written in another language.[61] To address this problem, a possible future research of #zerowaste hashtag should include other languages that are frequently used on this social media platform (such as Japanese, Spanish, Korean and Arabic), this will require a large and multilanguage team to analyse the data, but results can be illuminating on how the issue of ZW is perceived in non-Anglo-Saxon cultures. Another limitation of the study stems from the actual keyword selection and qualitative coding. We decided to use keywords closely associated with ZW lifestyle, packaging, food packaging and most commonly used packaging materials; however, we are aware that there might be a subset of tweets that refer to ZW and packaging that did not show in our analysis due to wording and social understanding of terms (e.g., the new, complex and evolving research area of bioplastic packaging) This can be corrected by more detailed dictionary and keyword linkage study of the terms associated with ZW and packaging in future Big Data Analysis. With regard to coding, this was done qualitatively by reading the most popular tweets and their meta-data by authors alone. In future more detailed studies of the problem, a more systematic coding methodology should be used. Lastly, there is a limitation of what was not analysed in this study. One of the biggest challenges of our world today that is very much connected to the social understanding of ZW is the challenge of food waste. This research area is very substantial, complex and linked to packaging and food packaging in a myriad of ways, and we consciously decided not to pursue it in this study, as it would require significant changes to the methodology.

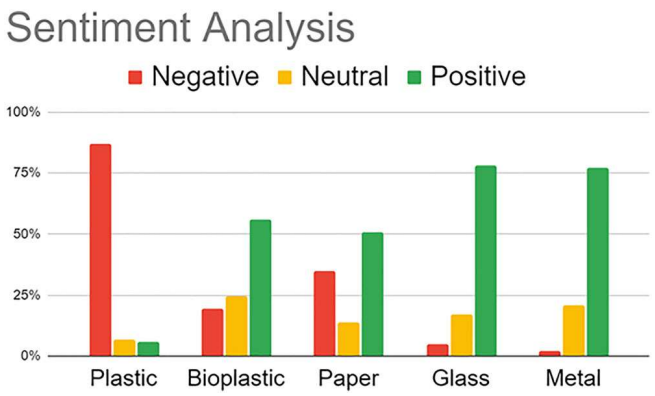

FIGURE 15 Summary of sentiment of all tweets with #zerowaste hashtag according to packaging material categories

4 | CONCLUSIONS

In our Thick Big Data study of 124,077 Twitter posts with #zerowaste hashtag, we investigated how many of them referred to packaging and more specifically food packaging and which waste prevention actions from the popular 5 R model were associated with them. We found out that the first and most important waste prevention action 'Refuse' was not connected to all tweets with #zerowaste hashtag (with only 3.3% of tweets quoting this word directly). In regard to food packaging materials, plastic is the main material linked to #zerowaste hashtag, with a share of occurrences of 88.4%. The sentiment of food packaging materials was negative for plastics, mixed for bioplastics and paper, and positive for glass and metal. The summary of sentiment analysis for all food packaging materials is presented in Figure 15. Twitter community that posted content with #zerowaste hashtag on packaging mostly focused on 'Reuse' and 'Recycling' as the main waste prevention actions.

Our study is important, as it shows that while ZW as a concept is very popular in social media, the actual communication about zero waste in the context of food packaging is largely overlooked and missing. People tweeting about ZW, presumably activists and good will citizens concerned about the climate catastrophe, predominantly focus on issues of lower importance and with little understanding of the 5 R inverted pyramid principles. This result is troubling, as they signal that the limited resources of public attention and effort are misdirected to topics that make much smaller impact, and the issues of larger impact do not surface in the public discourse. When investigating the most popular tweets in all packaging material categories, the results look slightly more promising, but still do not conform to sound understanding of the 5 R model.

The long-term consequences affect the food packaging producers, who also focus on the topics most frequently raised by the consumers and activists. While more research is needed to analyse the trends of public engagement about different packaging food materials, as well as the general attitude and sentiment towards different methods of contributing to zero waste, our study clearly indicates that much more education is needed, if the general public's involvement is not going to be wasted.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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