A Twitter Sentiment Analysis on Circular Economy

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This research aims to understand the development of public sentiment towards the circular economy. The research adopts a qualitative method with a focus on sentiment analysis using primary data obtained from Twitter. The tweet data is then processed using the VADER Python programming. The results show significant daily fluctuations in the number of tweets discussing the circular economy. The peak tweet activity occurs around the middle of the month, reaching a maximum of 970 tweets. London, England, is noted as the location with the highest tweet activity related to the circular economy, reaching a total of 666 tweets. In terms of sentiment, the majority of tweets exhibit a positive attitude with a percentage of 64.5%. This positive sentiment reflects optimism and support for the concept of the circular economy. The successful implementation of the circular economy paradigm is proven to develop sustainable business and development models, creating hope for a new supportive ecosystem, where economic, environmental, and social sectors are integrated.

Keywords: Circular Economy; Text Mining; R

INTRODUCTION

A circular economy is an economic system that aims to eliminate waste and use resources sustainably. In a circular economy, products and materials are reused, repaired, remanufactured, and recycled to create a closed-loop system, which minimizes the use of raw materials and the production of waste. This approach aims to maximize the value and usefulness of products and materials, while minimizing the impact on the environment. It is a regenerative system that aims to eliminate waste and pollution, keep products and materials in use, and regenerate natural systems. The concept of circular economy is gaining traction as a sustainable alternative to the traditional linear economy, which is based on the "take-make-dispose" model. Specifically, Circular Economy is defined as a holistic concept that includes reducing, reusing, and recycling activities in the production, circulation, and consumption processes, followed by reuse and recycling (Kirchherr et al., 2017). The concept of a circular economy is currently being promoted by many EU countries, including China, Japan, the UK, France, Canada, the Netherlands, Sweden, and Finland, as well as a number of businesses around the world. The European Commission estimates that transitioning to a circular economy can create economic benefits, as well as an approach to economic growth that is in line with sustainable environmental and economic development (Korhonen et al., 2018).

Several empirical studies have explained the benefits of the circular economy. Teekasap (2018) explains the benefits of the circular economy include reducing waste, conserving resources, and creating new business opportunities. By maintaining the use of materials, the circular economy can reduce the need for raw materials and energy, thus helping to reduce greenhouse gas emissions and other environmental impacts (Niwalkar et al., 2023). In addition, a circular economy can create new jobs and economic growth by encouraging innovation and the development of new technologies. Circular economy strategies can also provide economic benefits, such as reduced raw material costs in the long run (Teekasap, 2018). In the water and wastewater sector, circular economy strategies can extend the life of equipment and facilities, reduce repair costs and minimize environmental impacts associated with equipment replacement (Castellet-Viciano et al., 2022). On the other hand, a shift to a circular economy can boost economic growth by creating $4.5 trillion in economic opportunities, as it encourages companies to design products that last longer and can be reused or recycled (McGinty, 2021). The Ellen MacArthur Foundation (2023) estimates that this shift could increase GDP by USD 700 billion by 2030, positively impacting economies around the world.

While the benefits of the promoted circular economy are great, there are some drawbacks and/or issues that also come with it. The drawbacks of the circular economy include the potential for higher implementation costs compared to traditional linear economic models (Teekasap, 2018). In addition, changing consumer behavior and encouraging people to adopt new habits, such as repairing and reusing products rather than buying new ones, can be challenging. Some industries may also face challenges in transitioning to a circular economy, particularly those that rely on linear production and consumption models (Batlles-delaFuente et al., 2022). Furthermore, the concept of circular economy can be narrowly defined, and there is a need to develop specific tools to assess the circular economy of a company (Stanovskaya, 2022). Furthermore, the circular economy framework has not been comprehensively adapted to agriculture, and there are drawbacks stemming from food production, such as waste generation, biomass, water pollution, and greenhouse gas emissions (Batlles-delaFuente et al., 2022).

In addition, the circular economy also faces several challenges that need to be overcome as described in the research of Holly et al (2023), where one of the main challenges facing the circular economy is related to the achievability of the concept. The transition from a linear economy to a circular economy is complex and requires significant changes in the way products are designed, produced and consumed. This poses significant challenges. The circular economy also lacks clear strategic guidelines and standardization, making it difficult to implement and regulate. This can lead to inconsistencies in practice and hinder the widespread adoption of circular economy principles. Another challenge is the presence of economic barriers and limited access to finance, which can hinder the adoption of circular business models and practices. This includes the need for investment in new technologies and infrastructure to support circular processes.

On the other hand, in some situations there are still different sentiments and debates on the circular economy. The sentiment around the circular economy is mostly positive, focusing on the opportunities that

exist. Ivanova (2020) and Kucherenko & Martyniuk (2021) highlight the potential and prospects for the development of the circular economy, emphasizing the need for measures to drive this change and the unprecedented opportunities it creates for achieving prosperity and well-being. The circular economy is seen as a key driver of achieving the UN's 2030 agenda and sustainable development goals (Kucherenko & Martyniuk, 2021). Moreover, Kucherenko & Martyniuk (2021) added that the transition to a circular economy is seen as essential to address pressing global issues such as climate change and natural resource depletion. Additionally, the Ellen MacArthur Foundation (2023) explains the positive sentiment of the circular economy is seen as a huge creative opportunity, offering new profit opportunities, cost reductions, and stronger customer relationships for businesses. ING Bank's (2020) global study of 15,000 consumers revealed that 83% believe their behavior and choices can positively impact global environmental challenges, indicating a positive sentiment towards the circular economy among consumers. Business leaders have expressed strong interest in transitioning to a circular business model, and most are already planning or implementing the transition. This shows recognition of the potential benefits of the circular economy.

Despite the generally positive sentiment, there were also discussions on the challenges and barriers associated with the circular economy, such as the need for adequate measures to promote the transition, the narrow interpretation of the concept, and the need to develop specific tools to assess the circular economy of a company (Stanovskaya, 2022; Amirova et al., 2021). Research by Antonioli et al (2022) suggests that in the short term, it will be difficult for small and medium-sized enterprises (SMEs) to gain economic benefits from circular economy practices, thus posing challenges in its implementation. Garcés-Ayerbe et al (2019) explained that the transition to a circular economy is described as a gradual process for companies, with common barriers including administrative processes, regulations, lack of human resources, financing, investment, and cost-benefit considerations. Ivanova (2020) also emphasized that there is a need for public authorities to take adequate measures to encourage the development of a circular economy, suggesting that current conditions may not be fully conducive to the widespread adoption of a circular economy.

The various sentiments reflect the diversity of views and needs in the evolving circular economy, as well as the complexity of the associated opportunities, challenges and regulatory issues. The continued emergence of this debate may also affect the direction of circular economy development in the future. Therefore, this research tries to explore further the sentiment on the topic of halal pharmaceuticals. Some previous studies relevant to this research topic include Consoli et al (2022) analyzing in detail and aspect-based regarding economic and financial lexicon with sentiment analysis; Biswas et al (2020) studying the scope of sentiment analysis on news articles regarding the impact of economic collapse on major international stock markets and GDP in troubled economic conditions; Li & Chen (2014) identifying top sellers in the underground economy using deep learning-based sentiment analysis; Despoudi et al (2023) exploring factors that enable and hinder the adoption of Industry 4.0 for CE implementation in fruit and vegetable SMEs in India from a resource-based perspective; Mirzaei & Shokouhyar (2023) applied thematic analysis in identifying the role of circular economy in sustainable supply chain practices; and van Capelleveen et al (2021) examined a recommender system for circular economy related hazards of European waste catalog.

Based on some of the research found, there is no research that specifically examines sentiment analysis on circular economy. Therefore, this research aims to find out the extent to which existing research examines circular economy, gain a deeper understanding of how people and stakeholders respond and interact with the concept of circular economy at large, and identify aspects that can affect the development of circular economy. Sentiment analysis can provide valuable insights to direct a more comprehensive implementation of circular economy in the future.

METHOD

This research is a type of qualitative research using sentiment analysis methods. The data used in this research focuses on tweets available on the Twitter social media platform. The selection of Twitter as a social media research platform is based on the relative ease of accessing Twitter data. The platform provides users' opinions in 140 characters, this feature allows for more effective data analysis compared to longer texts and those containing many photos. In addition, Twitter enables research that includes the analysis of

both individuals and media within one analytical framework (Vargo et al., 2014).

The data for this study was collected from Twitter using circular economy-related keywords. A common method used to collect tweets from Twitter is usually through the website's Application Programming Interface (API), which allows developers and researchers to collect data. However, the API method still has many limitations, including only returning tweets from the last seven days and only allowing a limited number of requests to Twitter servers (Ainin et al., 2020). To overcome these obstacles, this research chose to collect data through the search feature of the Twitter website, using a Python script known as VADER (Valence Aware Dictionary and Sentiment Reasoner). VADER is a lexicon- and rule-based sentiment analysis tool specifically set up to identify sentiment expressed in social media, and works well with text from various domains. VADER facilitates sentiment analysis by calculating a composite score, which is used to classify tweets into three categories: positive, negative, and neutral (Liu, 2012).

In addition, using this feature, the user's location is extracted by developing a Python script.

Then, to identify duplicate tweets, the MD5 value of each tweet is calculated. MD5 itself is a hash function that returns a unique value for a given text (Ainin et al., 2020). Small changes in the text can change the hash value, thus, allowing researchers to identify duplicate tweets. This is considered a one-way encryption method, and has been widely used in the field of computer security (Ainin et al., 2020). Furthermore, the dataset includes non-duplicated tweets related to the topic of curcular economy based on the previously mentioned keywords. To ensure the relevance of the tweets, the researcher randomly filtered the dataset and manually analyzed 30 tweet texts. In other words, the sampling technique in this study uses purposive non-probability sampling, with the aim of obtaining information that suits the research objectives. Previous studies using sentiment analysis for the example can be seen at Maulida (2022), Maysyaroh et al., (2022), Maulida & Rusydiana (2022), and Haidar et al., (2022).
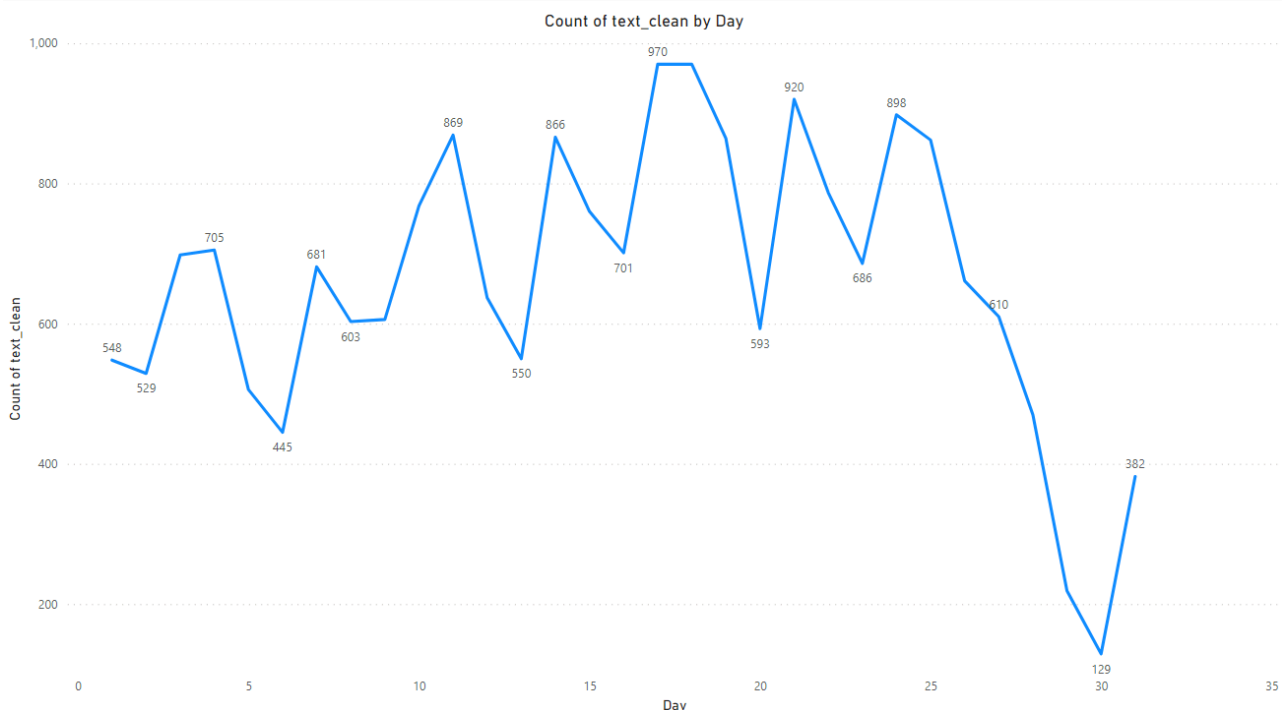
RESULTS AND ANALYSIS

Circular Economy

Figure 1. Count of Text Clean by Day

The figure above depicts a graph of the development of the number of net tweets about the circular economy every day during the research period. Based on the graph, it can be seen that the number of net tweets about the circular economy experienced a

fluctuating trend every day. As can be seen, the peak number of tweets about the circular economy occurred around the middle of the month, reaching a maximum of 970 tweets. Subsequently, there was a significant decline, with only 129 tweets on day 30. Nonetheless,

there was a slow increase in the following days. It is important to note that this study is dynamic in nature, so the results may change following trends influenced by specific variables. As a result, the number of tweets about the circular economy may decrease or increase on subsequent days.

Table 1. Location of Tweet Data Distribution

No.	Location	Total
1	London, England	666
2	United Kingdom	592
3	Brussels, Belgium	385
4	Global	235
5	Europe	167
6	India	159
7	Canada	151

The data presented reflects the participation of users from different countries in the discussion of the circular economy. The table above provides an overview of the user locations with the highest number of tweets, illustrating the extent to which this topic is gaining traction in different regions. London, UK, tops the list as the location with the most tweet activity around the circular economy, totaling 666 tweets.

Second place went to the UK with a total of 592 tweets. Meanwhile, Brussels, Belgium, came in third with 385 tweets. The distribution of the tweet data reflects the interest of twitter users in each of these regions in the topic of circular economy. This data provides further insight into the geographical distribution of circular economy conversations on social media.
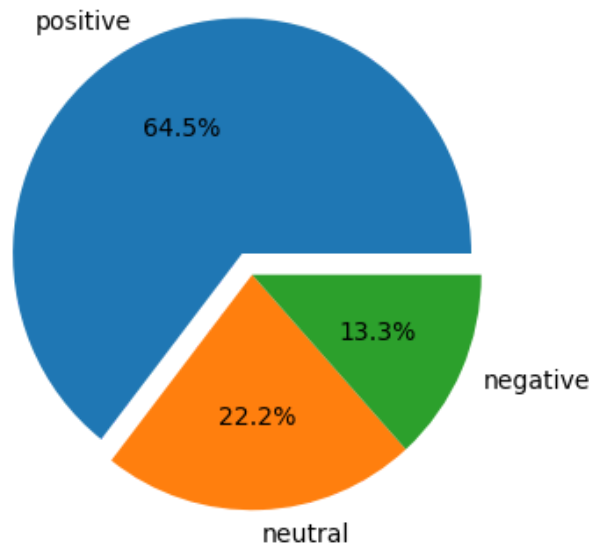

Figure 2. Sentiment Polarity on Tweets Data

The pie chart above reflects the polarity of sentiment in the circular economy-related tweet data. These sentiments were analyzed from tweets sent by Twitter users during the research period and classified using the VADER algorithm, which ranks positive, neutral and negative intervals automatically. From the analysis, positive sentiment dominated with a percentage of 64.5%. This shows that the majority of

Twitter users tend to positively welcome and support the existence of the circular economy, reflecting optimism towards the concept. Neutral sentiment came in second place with a percentage of 22.2%. This sentiment shows an attitude that does not show partiality, often reflecting information without clear opinions, only conveying facts or data related to the circular economy. On the other hand, negative

sentiment reached 13.3%, indicating that a minority of Twitter users expressed critical views or negative attitudes towards the circular economy. This could include concern, criticism, or disapproval of certain aspects of the circular economy concept.

Figure 3. Wordcloud Data Tweets

The figure presented is a visualization of the keywords that frequently appear in the tweet data regarding circular economy, with different colors to distinguish the keywords. The most frequently occurring keywords are shown with the largest size among the other words. In all three images, "circular economy" stands out as the most frequently occurring keyword in the circular economy tweet data.

Furthermore, in the word cloud containing positive tweets, key words such as "sustainable", "plastic", "environment", "product", and "technology" dominate the visualization. This reflects that when users express positive views towards the circular economy, they often associate it with sustainability, products, and technology. Meanwhile, in the word cloud containing negative tweets, key words such as "waste", "plastic", "recycled", and "sustainable" appear more frequently. This suggests that in negative contexts, attention is often focused on issues such as waste, plastic use and sustainability.

In the keyword visualization of the overall tweet data, it can be seen that "circular economy",

"sustainability", "supply chain", "waste", "recycling", "climate change", and "sustainable" are key words that appear frequently. This reflects the diversity of issues discussed in the circular economy conversation, including aspects such as supply chain, waste, recycling, and climate change.

DISCUSSION

This research aims to assess public sentiment regarding circular economy practices. The circular economy concept, which is a system designed to optimize resource use and reduce waste, brings with it a number of positive and negative issues that require special attention. The circular economy concept supports the sustainable use of resources by extending product life cycles and reducing the need for new raw materials. The implementation of the circular economy concept is in line with the achievement of various sustainable development goals. (Fasa, 2021) SDG 6 (ensuring the availability and sustainable management of clean water and sanitation), SDG 7 (ensuring access to affordable, reliable, sustainable and modern energy), SDG 8 (promoting inclusive and sustainable economic growth, productive and full employment opportunities, and decent work), SDG 12 (ensuring sustainable production and consumption patterns), and SDG 15 (protecting, restoring and enhancing the sustainable use of terrestrial ecosystems, sustainably managing forests, halting desertification, restoring land degradation, and halting biodiversity loss). (Schroeder et al., 2019).

Optimizing production processes and resource utilization within a circular economy framework has the potential to reduce carbon emissions and improve energy efficiency. Hasbi (2022) argues that the circular economy is not only concerned with better waste management, but also involves a holistic set of interventions from the beginning to the end of the material life cycle, as well as improving the efficiency of resource use. The principle of eco-efficiency underlying the circular economy concept benefits the industry through three aspects, namely reducing the cost per unit of product, reducing the negative environmental impact per unit of product, and increasing the competitiveness of the company. In addition, according to (Agusni, 2023) the application of circular economy provides benefits, especially in the efficient use of resources. By maintaining the use of resources or materials for as long as possible during the material life cycle, this practice can reduce the need for extraction of new raw materials, which in turn supports resource conservation and prevents environmental damage.

A focus on recycling and product renewal can also be a driver of innovation and create new jobs in the recycling and recovery industry. (Schroeder et al., 2019). The implementation of the circular economy concept opens up new opportunities for job creation, especially in sectors such as recycling, recovery and green technology innovation. Practices such as recyclable product design, renewable energy utilization, use of recycled materials, and effective waste management can be important pillars in supporting global goals related to sustainable economic growth. According to Kurnia et al. (2023) in the context of Sustainable Development Goal (SDG) Number 8, the concept of circular economy has great potential to support the achievement of various goals, including sustainable economic growth, creation of decent work, access to finance, protection of labor rights, reduction of child labor, and elimination of forced labor. The circular economy paradigm is considered as one of the instruments that can have an overall positive impact on various aspects of economic and social life, in accordance with the vision and mission of SDG Number 8. The implementation of the circular economy is expected to make a real contribution to global efforts to achieve these goals.

The successful implementation of the circular economy paradigm is proven to develop sustainable business and development models, creating hope for a new supportive ecosystem, where economic, environmental, and social sectors are integrated. (Hasbi, 2022). Nonetheless, a number of industries and businesses may need to adapt their business models to fit the principles of the circular economy. The challenges faced mainly arise when business models that have proven to be successful have to undergo significant changes. Circular economy approaches in a business context can show great variation, depending on the extent of its application in a particular industry (Jayawati et al., 2020).

The transition to a circular economy can also require substantial initial investment in new technologies and infrastructure, which can be a financial burden for some. Circular economy systems emphasize waste productivity and recovery. Waste management requires significant changes in the structure of the waste management system, which can lead to new problems, including increased external costs. Therefore, an in-depth understanding of a community's waste cycle is essential before making policy decisions. (Kristianto & Nadapdap, 2021).

CONCLUSION

The results showed that the number of tweets about the circular economy experienced significant daily fluctuations. The peak of tweet activity occurred around the middle of the month, reaching a high of 970 tweets. London, UK, was recorded as the location with the most tweet activity around the circular economy, reaching a total of 666 tweets. In terms of sentiment, the majority of tweets were positive with a percentage of 64.5%. This positive sentiment reflects optimism and support for the circular economy concept. Neutral sentiment came in second place with a percentage of 22.2%, which shows an impartial attitude and tends to only convey facts without clear opinions. Meanwhile, negative sentiment reached 13.3%, indicating that a minority of Twitter users expressed critical views or negative attitudes towards the circular economy. Further analysis may be needed to understand the factors that influence high tweet activity in specific locations, such as government initiatives, local trends or special events that trigger user interest. This could provide deeper insights into the dynamics of the circular economy conversation and the factors that influence people's perceptions and participation.

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