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The role of hashtags for non-profit causes: the #fridaysforfuture movement

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Abstract

Social movements are gaining increasing popularity, especially those related to environmental protection, partly due to their usage of online social media to disclosure information. Tools like hashtags, which help tag and categorize posts, as well as make them more accessible to other users, are also responsible for their popularity. Therefore, this study aims to analyze how hashtags contribute to information disclosure through online social media, focusing on the social movement Fridays for Future and in the social media platform Twitter. Based on 647 tweets containing the hashtag #fridaysforfuture and 503 comments of these tweets, this research delves into examining the content and format of tweets and their associated comments, aiming to identify those that generate more reactions from users, and more exactly during the lockdown produced by COVID-19. Results indicate that most tweets include contents related to interaction and dialogue with other users, and the most used format is textual. With respect to the analysis of comments (of these tweets), the majority express support for the movement in textual format. Tweets that generate more reactions are those that combine content about action, mobilization, digital strike, and COVID-19 in textual format, along with other hashtags related to sustainability/digital strike and images. Regarding the replies to the comments (of these tweets), only the video format generates a greater number of responses. These results describe how to design a message by a famous social movement, offering valuable insights to empower other social movements in shaping their effective social media strategies.

Keywords Twitter · Hashtag · Fridays for future · Environmental protection · Sustainability · Social movement

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1 Introduction

Social movements are gaining popularity through social media as they reach many people who follow and advocate for them. The use of hashtags helps social movements to tag and categorize their posts, making them more accessible to other users. The case of the hashtag #BlackLivesMatter is a clear example of the impact of this tool. Thanks to this hashtag, millions of people worldwide expressed their outrage and support in response to the racist incidents that occurred in the United States after the acquittal of George Zimmerman for the shooting death of the African American teenager Trayvon Martin.

Sustainability and particularly environmental protection is becoming an increasingly prominent topic in social movements. In fact, the contemporary rise of environmentalism on the Internet in the mid-1990s was not a coincidence (Yang, 2005). The emergence of web-based environmental non-governmental organizations (ENGOs) and green virtual communities has sparked interest as case studies on how the Internet potentially 'facilitates the creation of new institutions for social change' (Yang, 2003). Among the movements advocating for planet protection, we highlight the Fridays for Future movement and its hashtag #fridaysforfuture, where individuals interact and raise awareness about global warming. This movement has gained significant traction, thanks in part to the young activist Greta Thunberg. Due to its significance as a social movement advocating for environmental protection and its exemplary use of technology, Internet, and social networks in activism, this research focuses on exploring and describing the use of the hashtag #fridaysforfuture on Twitter.

Previous studies on social movements using social media have focused on platforms such as Twitter, Instagram and Facebook, specifically those related to political issues or topics concerning environmental protection, or social causes (e.g., Herrmann et al., 2023; Schürmann, 2023; Venkatesan et al., 2021). Many of these studies focus on the analysis of interviews and/or surveys with activist to understand their attitudes and opinions about the movement or related topics (Cologna et al., 2021; Mundt et al., 2018). Other important group of studies focus on analyzing a sample of messages extracted from the official social media accounts of the social movement, activists, or other opinion leaders to study their communication strategy (Schürmann, 2023). Another research stream deals with social media posts identified by a hashtag or a group of hashtags to analyze message senders and observe connections among them (Mirbabaie et al., 2021), or to develop a thematic analysis of these posts (Li et al., 2021; Schürmann, 2023). However, few studies delve into the examination of the content and format of tweets and their associated comments, aiming to identify those that generate more reactions from users in the specific case of the Fridays for Future social movement, and more exactly during the lockdown produced by COVID-19. With the emergence of the COVID-19 pandemic in the beginning of 2020, organizers of Fridays for Future found themselves managing a crisis compelled to shift their physical events into the digital realm (Sorce & Dumitrica, 2023). Hence, exploring the nature of communication, its format, and user reactions in this scenario emerges as a compelling avenue for research.

Therefore, this work aims to fill the research gap created by the scarcity of studies focusing on analyzing the Fridays for Future social movement, and to be more precise

during the lockdown produced by COVID-19. Particularly, this study addresses the need for greater understanding of the extent of usage and impact of hashtags on Twitter social network, specifically using the hashtag #fridaysforfuture. Consequently, the main objective of this research is to describe the usage of hashtags on Twitter to promote online social movements related to environmental protection addressing the following research questions:

- Research question nº 1a: What are the main topics or content types of tweets tagged with the hashtag #fridaysforfuture on Twitter?
- Research question nº 1b: In what formats tweets tagged with the hashtag #fridaysforfuture are published on Twitter?
- Research question nº 1c: Which tweet content type(s) and format(s) obtain more users reactions (second level, i.e., reactions related to main tweets)?
- Research question nº 2a: What are the main topics or content types of comments related to tweets tagged with the hashtag #fridaysforfuture on Twitter?
- Research question nº 2b: In what formats comments related to tweets tagged with the hashtag #fridaysforfuture are published on Twitter?
- Research question nº 4: Which comment content types(s) and format(s) obtain more responses (third level, i.e., responses to comments related to main tweets)?

To solve these questions this study analyses 647 tweets containing #fridaysforfuture and 503 comments of these tweets published on Twitter during the month of March 2020, that is, during the lockdown produced by COVD-19. Main results related to tweets revealed that most of them include contents related to interaction and dialogue with other users, and the most used format is textual, including other hashtags related to sustainability. With respect to the analysis of comments (to main tweets), the majority express support for the movement also in textual format. Tweets that generate more reactions are those that combine content about action, mobilization, digital strike, and COVID-19 in textual format, along with other hashtags related to sustainability/digital strike and images. Regarding the replies to the comments (of these tweets), only the video format generates a greater number of responses. These findings aim to provide a valuable reference for other non-profit causes and social movements by highlighting the most and least published content types and formats as well as those that generate more reactions in other users within an established movement such as Fridays for Future, encompassing both offline and online realms. Hence, the primary contribution of this proposed research is to advance the understanding of the usage of hashtags as a communication tool for social movements, specifically for the Fridays for Future movement and during a specific period (lockdown produced by COVID-19). It explores how, through the hashtag, a singular message can transcend international borders, even when languages differ, and when social contact is restricted. This research sheds light on how the hashtag plays a crucial role in amplifying an environmentally focused social movement on Twitter.

2 Literature review

2.1 Fridays for future social movement

The Fridays for Future movement begin in August 2018 when a 15-year-old girl, Greta Thunberg, and other young activists initiate a school strike, advocating for the climate cause. For three weeks, these young individuals sit in front of the Swedish parliament demanding urgent action on the climate crisis. This movement gradually reaches more people who join Greta in this fight. Since this Greta Thunberg's first protest in 2018, Fridays for Future (hereafter FFF) has become transnationally recognized for its iconic climate activism (Sorce & Dumitrica, 2023). Greta's actions trigger an international awakening, leading fellow students and activists worldwide to protest in front of their respective local parliaments and city halls.

On September 8, 2018, Greta decided to continue the strike every Friday until Swedish policies provided a safe path below 2 °C, in line with the Paris Agreement. This agreement is the first universal and legally binding accord on climate change adopted at the Paris Climate Conference (COP21) in December 2015. The Paris Agreement establishes a global framework to prevent dangerous climate change by keeping global warming well below 2 °C and striving to limit it to 1.5 °C. The agreement also aims to enhance the climate change resilience of countries and support their efforts. It serves as a bridge between current policies and the climate neutrality that must be achieved by the end of the century.

Therefore, the main objective of this movement is to exert moral pressure on policymakers, compelling them to heed scientists and take energy measures that limit global warming. This is a movement independent of commercial interests and political parties, transcending borders. What motivates Fridays for Future activists is caring for the planet and others, with the hope that humanity can change, thereby avoiding worse climate disasters and building a better future. As defined on the official page of this movement, Fridays for Future "is part of a hopeful new wave of change". Their demands are summarized in the Declaration of Lausanne, developed in August 2019 by 400 climate activists from 38 countries, and include: (1) keep the global temperature rise below 1.5 °C compared to pre-industrial levels, (2) ensure climate justice and equity, and (3) listen to the best united science currently available.

Some of the actions carried out by Fridays for Future movement include, for example "Talks For Future" (webinars guided by activists), "Stop Subsidizing Fossil Fuels" (campaign to promote new policies in financial institutions resulting in a faster phase-out of coal, gas, and oil), "EU Citizens' Action on Climate Emergency" (a citizen initiative collecting signatures to compel the European Commission to take a stance and the EU Parliament to hold a public hearing on the issue), FFF Online Trainings (virtual training sessions to spread the movement in different areas, recruit, and organize volunteers), among others. To disseminate all its activities, the movement makes use of a specific hashtag on social media. Hashtags are a mean that social media has found to gather everything said about a specific topic along a social media platform. In this case, hashtag related to this social movement is #fridaysforfuture. There is limited knowledge regarding this movement, Fridays for Future, and its

relationship with social media, specifically Twitter. This research aims to fill this research gap.

2.2 Activism of social movements through social media and hashtags usage

Social movements are social groups engaging in sustained collective actions, sharing a common purpose, and challenging the interests and beliefs of those in power (Tarrow, 2005). In line with this definition, Harlow (2012) defines activism as "the action of a group of like-minded individuals coming together to change the status quo by advocating for a cause, whether local or global". Internet and social media, along with other traditional media used to promote social movements, enables transnational action that is cost-effective and not constrained by time, space, or distance (Juris, 2005).

Online social media, especially Twitter, have been regarded as platforms for protest and a vehicle to give voice to people and provide support for action on the streets (Smith et al., 2019). Particularly Twitter is considered as a medium to facilitate discussion, political engagement, and knowledgeability (Lynn et al., 2020) as well as giving non-traditional actors a voice in socio-political debates. Specifically, hashtags, which originated on Twitter, have emerged as a prominent online communication tool for several social movements, addressing a wide range of topics and fields. They play a pivotal role in contemporary social movements, facilitating communication and self-expression across social media platforms. Hashtags empower advocacy of support, participation in protests, and engagement in discussions surrounding various social issues (Natalia et al., 2023).

Previous research about online activism using hashtags, or hashtags activism, is mainly focused on Instagram and Facebook, as well as on Twitter (e.g., Herrmann et al., 2023; Schürmann, 2023; Venkatesan et al., 2021). In particular, they analyze online activism related to political issues (Isa & Himelboim, 2018; Lynn et al., 2020; Venkatesan et al., 2021), environmental protection (Sorce & Dumitrica, 2023), or social causes such as feminism (Kaufman et al., 2021) or racism (Yang, 2016) using different hashtags as a way to identify posts and collect them. The majority of this research is centered in analyzing message senders and observe connections among them (Isa & Himelboim, 2018; Mirbabaie et al., 2021; Oliveira et al., 2023). The main goal of these network analyses is to understand patterns of interactions around hashtags and therefore action-participation within the social movement (i.e., mainly if they present and organized or a disorganized pattern of interactions); who initiate conversations, who moderates conversations or who are the most visible faces are other interesting outputs of these network analyses.

Other group of research about hashtag activism develops thematic analysis or topic modelling of the tweets identified by a specific hashtag or group of hashtags (Li et al., 2021; Schürmann, 2023). Social media, and specially Twitter, are considered important sources of data for analyzing discourses on a specific topic, such as environmental protection and/or climate change (Fernández-Zubieta et al., 2023). This line of research is of particular interest because it helps identify the most popular topics, what the audience is most interested in, and the strategies and actions that generate the most mobilization (Haßler et al., 2023). However, despite many studies

focusing on analyzing the content of tweets including a social movement hashtag, few also delve into the examination of their format, the comments and other reactions they generate, and specifically for the Fridays for Future movement and during a specific period (lockdown produced by COVID-19), which is the main goal of the proposed research.

3 Methodology

3.1 Sampling and data collection

A comprehensive dataset is compiled, consisting of 69,897 tweets bearing the hashtag #fridaysforfuture, posted in March 2020. TAGS v6.1.9.1 tool (http://tags.hawksey.info/about/) is used to collect this dataset. Given that specific variables in this study required manual processing, a representative random sample of around 1% of these tweets was generated. Following the exclusion of retweets and replies, our final database comprises 647 original tweets and 503 associated comments. The total number of comments related to the main 647 tweets is 7,659. However, as is previously stated, as specific variables in this study required manual processing, to reduce the sample size only the first ten responses to each tweet were analyzed, as they represent the initial impressions the tweet makes on its senders. This resulted in 503 analyzed responses, which corresponds to 6.67% of the total comments. Only comments on the main tweet were analyzed; responses to these comments were not analyzed as they were mostly nonexistent or simply emoticons. Three independent coders participated in the manual processing of several variables. Discrepancies between two of the three coders were addressed and resolved by the third coder. The intercoder reliability, calculated using Holsti's (1969) formula, surpasses the necessary minimum threshold, with a reliability score of 0.85, exceeding the 0.80 minimum requirement.

3.2 Measurement of variables

TAGS v6.1.9.1 tool, used to collect tweets for this research, automatically collects information related to each tweet, for example text of the tweet, publication date and time, if it is a retweet or a reply, username who published the post and his/her number of followers. In addition, this study encompasses two more sets of variables that are manually processed.

The first set of variables comprises those variables associated with *tweets*, specifically focusing on content type, content format and total number of users' reactions to these tweets (for a summary of these variables see Table 1).

Firstly, regarding the variable *tweet content type*, the categorization of this variable is based on the original classification of website content types related to social movements provided by Stein (2009). These categories include:

- Tweets containing information related to the Fridays for Future social movement, information related to sustainability topics, information linked to social issues (such as International Women's Day or Labor Day), and other more generalized

Table 1 Variables related to tweets considered in this study

Variables	Categories
Tweet content type (adapted from Stein (2009))	Information about Fridays for Future
	Information related to sustainability topics
	Information related to social issues
	Information not related to sustainability topics
	Action and mobilization
	Interaction and dialogue
	Creative expressions
	Fundraising and resources
	Covid-19
	Digital Strikes
	Tweets that erroneously use hashtag #fridaysforfuture
Tweet content format (adapted from Shahbaznezhad et al. (2021))	Textual information
	Links
	Other hashtags related to sustainability
	Other hashtags not related to sustainability
	Other hashtags related to COVID-19
	Other hashtags related to digital strikes
	Image/s
	Video/s
Tweet users' reactions in the form of likes (Muñoz-Expósito et al., 2017)	Total number of likes linked to each tweet
Tweet users' reactions in the form of shares (Muñoz-Expósito et al., 2017)	Total number of shares linked to each tweet
Tweet users' reactions in the form of comments (Muñoz-Expósito et al., 2017)	Total number of comments linked to each tweet
Tweet users' reactions in the form of responses to comments (Muñoz-Expósito et al., 2017)	Total number of responses to comments linked to each tweet

information not related to sustainability. Within these categories reflecting information are included news articles, media/press releases, self-published articles or leadership speeches and articles.

- Tweets promoting action and mobilization, including those tweets comprising online petitions, coordinated online actions, calendar or events and project or campaign descriptions.
- Tweets expressing interaction and dialogue, for example when tweets contain plans for holding meetings online or when tweets contain online polls and surveys asking for users' participation.

- Tweets containing different forms of creative expressions, such as songs, poetry, or other forms of visual art.
- Tweets asking for fundraising and resources (e.g., volunteer sign-up, solicit donations).
- Tweets related to COVID-19 are also distinguished since, within the analyzed timeframe, this topic holds significant importance.
- Tweets about digital strikes comprise those tweets that are associated with another hashtag emerging from this situation, aiming to manifest online, namely, #DigitalStrike. Some examples of tweets containing different content types are included in Figs. 1, 2 and 3.

With respect to the variable related to *tweet content format*, and based on Shahbaznezhad et al. (2021), different categories include whether the tweet contains textual information, links, other hashtags related to sustainability (e.g., #climateaction, #actonclimate, #stopecocide), other hashtags unrelated to sustainability (e.g., #academicTwitter, #usa), other hashtags related to COVID-19 (e.g., #stayathome, #staysafe #covid19uk), other hashtags related to #DigitalStrike (e.g., #digitalstrike, #climatestrikeonline), images, or videos. As with the previous categories, some examples are provided below in Figs. 4, 5 and 6.

Fig. 1 Tweet containing information related to Fridays for Future

Fig. 2 Tweet containing information related to social issues

Finally, different reactions to tweets and comments are collected (Muñoz-Expósito et al., 2017), such as total number of likes, shares and comments linked to each tweet, as well as total number of responses to comments linked to each tweet.

The second set of variables comprises several variables related to comments of the collected tweets, with a focus on content type, content format and users' responses to these comments. Particularly, with respect to the variable *comment content type*, categories are also derived from Stein (2009), but have been suitably adjusted to align with the content encompassed by the analyzed comments. The resulting categories include those comments that give support for the movement, those that express complaints (particularly about the movement, climate change, and/or the action of environmental protection), those that express gratitude to the movement or to the author of the tweet, or other topics (these cases generally include emoticons or links not related to the previous categories). Comment content format and comment users' reactions are included and described in Table 2.

3.3 Data analysis and results

To solve the research questions presented at the beginning of this study, descriptive analysis, hierarchical and k-means clusters and ANOVAS are performed.

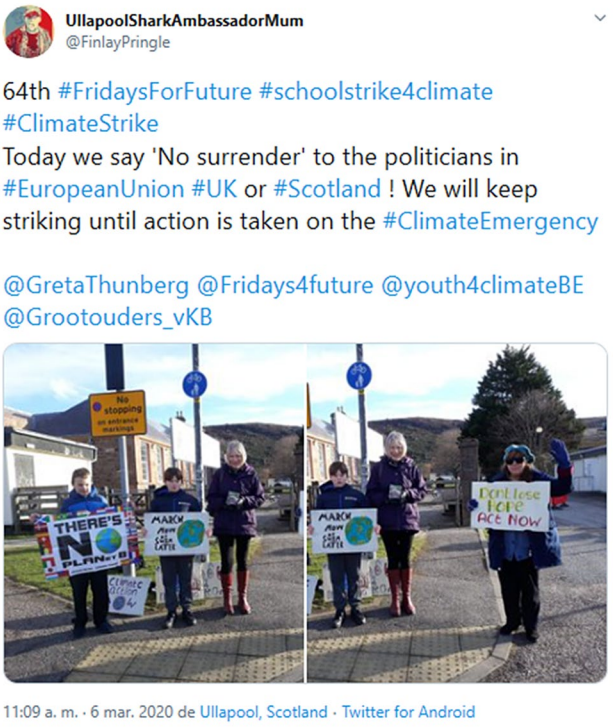

Fig. 3 Tweet containing information related to action and mobilization

Fig. 4 Tweet containing textual information, links and other hashtags related to digital strike

Fig. 5 Tweet containing textual information, links and other hashtags related to sustainability and not related to sustainability

Fig. 6 Tweet containing textual information, other hashtags related to #digitalstrike and image

Table 2 Second set of variables considered in this study (related to comments of the collected tweets)

Variables	Categories
Comment content type (adapted from Stein (2009))	Support for the movement
	Complaint
	Gratitude
	Others
Comment content format (adapted from Shahbaznezhad et al. (2021))	Textual information
	Links
	Other hashtags related to sustainability
	Other hashtags not related to sustainability
	Other hashtags related to COVID-19
	Image/s
	Video/s
Comment users' reactions (Muñoz-Expósito et al., 2017)	Total number of responses to comments
Comment users' reactions by the author of the main tweet (Muñoz-Expósito et al., 2017)	Total number of responses to comments written by the author of the tweet
Comment users' reactions by Fridays for Future (Muñoz-Expósito et al., 2017)	Total number of responses to comments written by Fridays for Future

3.3.1 Research questions 1a, 1b and 1c about tweets

First, to get a solution for the research question nº 1a (i.e., What are the main topics or content types of tweets tagged with the hashtag #fridaysforfuture on Twitter?), descriptive results in the form of frequencies of each category related to the variable *tweet content type* are obtained. Most of the tweets are related to interaction and dialogue, encouraging people to participate in webinars and discussions about this movement. The second most significant category of content includes tweets referencing action and mobilization, displaying multimedia content from past or ongoing activities, and urging movement followers to act. In third place, there is a substantial number of tweets discussing Digital Strike or Climate Strike Online. In fourth place are tweets referring to COVID-19. The fifth category includes tweets containing information on sustainability topics, followed by those informing about the movement, i.e., providing information about Fridays for Future. The categories generating the least content include creative expression, other information not related to sustainability, information related to social issues such as International Women's Day, and finally, tweets related to fundraising and resources. Results are summarized in in Table 3.

To delve into the usage and combinations of different *tweet content types*, a hierarchical cluster utilizing the agglomeration method of minimum distance, with Sokal and Sneath's distance measure, owing to the dichotomous nature of the data is performed (Vilá-Baños et al., 2014). Following this, a non-hierarchical k-means clustering has been conducted, thereby circumventing the primary issues and constraints of

Table 3 Frequencies of each category of the variable *tweet content type*

Categories of tweet content type	Number of tweets
Information about Fridays for Future	52
Information related to sustainability topics	104
Information related to social issues	12
Information not related to sustainability topics	29
Action and mobilization	173
Interaction and dialogue	198
Creative expressions	37
Fundraising and resources	9
COVID-19	103
Digital Strike	143

Table 4 Final cluster center for tweet content type

Categories of tweet content type	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Information about Fridays for Future	0	0	0	0	0
Information related to sustainability topics	0	0	0	1	0
Information related to social issues	0	0	0	0	0
Information not related to sustainability topics	0	0	0	0	1
Action and mobilization	0	1	1	0	0
Interaction and dialogue	1	0	0	0	0
Creative expressions	0	0	0	0	0
Fundraising and resources	0	0	0	0	0
COVID-19	0	0	1	0	0
Digital Strike	0	1	1	0	0

Table 5 Number of observations in each cluster for tweet content type

Cluster 1	336
Cluster 2	126
Cluster 3	52
Cluster 4	104
Cluster 5	29
Total	647

the aforementioned technique (Punj & Steward, 1983). The results obtained identify five different groups of tweet content type combination (see Tables 4 and 5). Cluster 1, composed of 336 cases, is distinguished by its inclusion of content focusing on interaction and dialogue. Cluster 2, consisting of 126 cases, comprises content discussing action, mobilization, and the digital strike. Cluster 3, formed by 52 cases, not only encompasses content related to action, mobilization, and the digital strike but also includes COVID-19 content. The content forming cluster 4, totaling 104 cases, primarily concern information related to sustainability topics. Lastly, cluster 5, with 29 cases, contains content covering information not related to sustainability topics.

Table 6 Frequencies of each category of the variable *tweet content format*

Categories of tweet content format	Number of tweets
Textual information	638
Links	300
Other hashtags related to sustainability	406
Other hashtags not related to sustainability	274
Other hashtags related to COVID-19	90
Other hashtags related to digital strikes	136
Image/s	281
Video/s	72

Table 7 Final cluster center for tweet content format

Categories of tweet content format	Cluster 1	Cluster 2	Cluster 3
Textual information	1	1	1
Links	1	0	0
Other hashtags related to sustainability	1	0	1
Other hashtags not related to sustainability	0	1	0
Other hashtags related to COVID-19	0	0	0
Other hashtags related to digital strikes	0	0	1
Image/s	0	0	1
Video/s	0	0	0

Table 8 Number of observations in each cluster for tweet content format

Cluster 1	239
Cluster 2	205
Cluster 3	203
Total	647

Second, to get a solution for the research question nº 1b (i.e., In what formats tweets tagged with the hashtag #fridaysforfuture are published on Twitter?), descriptive results in the form of frequencies of each category related to the variable *tweet content format* are obtained. Table 6 presents the results of the analyzed categories, showing that textual information accompanying other hashtags related to sustainability and links are the most frequently utilized.

To delve into the usage and combinations of different *tweet content format*, a hierarchical cluster following of a non-hierarchical k-means clustering has been conducted. The results showed three different groups of tweet content format (see Tables 7 and 8). Cluster 1, comprising 239 cases, is characterized by the combination of textual format, links, and other hashtags related to sustainability. Cluster 2, consisting of 205 cases, primarily combines textual format with other hashtags not related to sustainability. Finally, Cluster 3, with 203 cases, combines textual format, other hashtags related to sustainability, other hashtags related to digital strikes and images.

Third, to get a solution for the research question nº 1c (i.e., Which tweet content type(s) and format(s) obtain more users reactions (second level, i.e., reactions related to main tweets)?), two ANOVAS analyses have been conducted using the variables consisting of the groups identified in the cluster analysis for tweet content type and

Table 9 Comparison of user reaction between tweet content type cluster

User reaction	Mean (SD)					F(df)	sig
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5		
Number of likes	217.12(3300.8)	345.20(1692.9)	1460.81(5718.2)	12.38(52.1)	4.97(9.1)	2.36(4)	0.051*
Number of shares	23.36(250.6)	64.82(292.2)	237.56(845.4)	6.58(26.0)	2.76(3.9)	5.50(4)	0.001**
Number of comments	7.26(109.8)	9.70(54.5)	76.10(332.7)	0.37(1.4)	0.10(0.4)	3.82(4)	0.004**
Number of responses	0.31(2.8)	0.94(4.8)	0.23(0.7)	0.10(0.6)	0.03(0.1)	1.52(4)	0.194

Note significant at *$p<0.1$; **$p<0.05$

Note 2: SD = standard deviation and df = degrees of freedom

Table 10 Comparison of user reaction between tweet content format cluster

User reaction	Mean (SD)			F(df)	sig
	Cluster 1	Cluster 2	Cluster 3		
Number of likes	49.64(534.19)	34.70(154.54)	861.40(5262.36)	5.30(2)	0.005**
Number of shares	10.45(79.06)	9.92(36.88)	121.20(576.35)	8.02(2)	0.001**
Number of comments	1.05(9.43)	0.96(3.95)	35.52(223.77)	5.26(2)	0.005**
Number of responses	0.11(1.00)	0.22(0.93)	0.85(5.14)	3.75(2)	0.024**

Note significant at **$p<0.05$

Note 2: SD = standard deviation and df = degrees of freedom

format, along with variables that capture the number of user reactions (such as likes, comments, shares, and replies). As demonstrated in Table 9, significant differences exist among the five identified clusters based on tweet content type and the number of likes, shares, and comments generated by users. Specifically, the number of likes, shares, and comments is higher in Cluster 3, which encompasses tweets with content related to action, mobilization, digital strikes and COVID-19, compared to the other groups. Similarly, significant differences exist between user reactions and the tweet format combinations identified within the three clusters. As showed Table 10, these differences are notable across all analyzed reactions. Cluster 3 stands out as the cluster generating a higher number of likes, shares, comments, and responses. This cluster is characterized by a combination of textual format, other hashtags related to sustainability, or digital strikes, along with images.

3.3.2 Research questions 2a, 2b and 2c about comments

First, to get a solution for the research question nº 2a (i.e., What are the main topics or content types of comments related to tweets tagged with the hashtag #fridaysfor-

Table 11 Frequencies of each category of the variable *comment content type*

Categories of comment content type	Number of comments
Support for the movement	211
Complaint	97
Gratitude	51
Others	146

Table 12 Frequencies of each category of the variable *comment content format*

Categories of comment content format	Number of comments
Textual information	481
Links	24
Other hashtags related to sustainability	58
Other hashtags not related to sustainability	12
Other hashtags related to COVID-19	7
Image/s	45
Video/s	12

future on Twitter?), descriptive results in the form of frequencies of each category related to the variable *comments content type* are obtained. Most comments on these tweets express support for this social movement, followed by comments categorized as "others", which include comments unrelated to the previous categories or they are simple emoticons or links to other pages. Following this category are comments expressing complaints about the main tweet content, the movement itself, or even the person writing it. Finally, we find the category of comments expressing gratitude for the movement, or for the individuals acting and writing the main tweet. A summary of these results is shown in Table 11. For the comment content type a cluster analysis has not been conducted due to these being mutually exclusive categories. There are no comments that exemplify a combination of any of the categories within this variable simultaneously.

Second, to get a solution for the research question nº 2b (i.e., In what formats comments related to tweets tagged with the hashtag #fridaysforfuture are published on Twitter?), descriptive results in the form of frequencies of each category related to the variable *tweet content format* are obtained. These results indicate that most comments contain textual information, followed by those containing other hashtags related to sustainability, comments that include images, and comments that contain links. The remaining categories, such as comments that contain videos, hashtags not related to sustainability, and other hashtags related to COVID-19, are less frequently used. A summary of these results is included in Table 12.

To delve into the usage and combinations of different *comment content formats*, a hierarchical cluster following of a non-hierarchical k-means clustering has been conducted. The results showed three different groups of comment content format (see Tables 13 and 14). Cluster 1, comprising 414 cases, is characterized by the used of textual format. Cluster 2, consisting of 58 cases, primarily combines textual format with other hashtags related to sustainability. Finally, Cluster 3, with 31 cases, combines textual format and images.

Third, to get a solution for the research question nº 1c (i.e., Which tweet content type(s) and format(s) obtain more users reactions (second level, i.e., reactions

Table 13 Final cluster center for comment content format

Categories of comment content format	Clúster 1	Clúster 2	Clúster 3
Textual information	1	1	1
Links	0	0	0
Other hashtags related to sustainability	0	1	0
Other hashtags not related to sustainability	0	0	0
Other hashtags related to COVID-19	0	0	0
Image/s	0	0	1
Video/s	0	0	0

Table 14 Number of observations in each cluster for comment content format

Cluster 1	414
Cluster 2	58
Cluster 3	31
Total	503

Table 15 Comparison of responses to comments between comment content types

Comment content types		Mean (SD) Responses to comments related to main tweets	F(df)	*sig*
Support for the movement	Ausence	0.07(0.25)	0.54(1)	0.459
	Presence	0.09(0.28)		
Complaint	Ausence	0.09(0.28)	2.48(1)	0.121
	Presence	0.04(0.20)		
Gratitude	Ausence	0.08(0.26)	0.26(1)	0.607
	Presence	0.10(0.30)		
Others	Ausence	0.08(0.26)	0.02(1)	0.888
	Presence	0.08(0.27)		

Note significant at $^{**}p<0.05$

Note 2: SD=standard deviation and df=degrees of freedom

related to main tweets)?), several ANOVAS analyses have been conducted. On the one hand, an-ANOVA analysis has been applied between the variables of the different comment content types and format with the responses to the comments related to the main tweets. On the other hand, an-ANOVA has been carried out between the variable that comprises the groups identified in the cluster analysis for the comment content format, together with the variable that captures the number of responses to comments related to main tweet (see Tables 15, 16 and 17). The results only showed significant differences between the comment content video format and the response to comments related to main tweets. The average response to comments is slightly higher when the comment content format is a video.

Table 16 Comparison of responses to comments between comment content format cluster

Responses	Mean (SD)			F(df)	sig
	Cluster 1	Cluster 2	Cluster 3		
Responses to comments related to main tweets	0.09(0.28)	0.03(0.18)	0.03(0.18)	1.55(2)	0.213

Note significant at $^{**}p<0.05$

Note 2: SD = standard deviation and df = degrees of freedom

Table 17 Comparison of responses to comments between comment format types

Comment format types		Mean (SD) Responses to comments related to main tweets	F(df)	*sig*
Textual information	Ausence	0.09(0.29)	0.04(1)	0.840
	Presence	0.08(0.27)		
Links	Ausence	0.08(0.27)	0.00(1)	0.944
	Presence	0.08(0.28)		
Other hashtags related to sustainability	Ausence	0.09(0.28)	1.81(1)	0.178
	Presence	0.03(0.18)		
Other hashtags not related to sustainability	Ausence	0.08(0.27)	0.00(1)	0.961
	Presence	0.08(0.28)		
Other hashtags related to COVID-19	Ausence	0.08(0.26)	0.38(1)	0.534
	Presence	0.14(0.37)		
Image/s	Ausence	0.09(0.27)	2.21(1)	0.137
	Presence	0.02(0.14)		
Video/s	Ausence	0.08(0.26)	4.90(1)	0.027**
	Presence	0.25(0.45)		

Note significant at $^{**}p<0.05$

Note 2: SD = standard deviation and df = degrees of freedom

4 Conclusions and discussion

Online social media, especially hashtags, which originated on Twitter, have emerged as a prominent online communication tool for several social movements, facilitating communication and self-expression across social media platforms. Hashtags helps social movements to tag and categorize their posts, making them more accessible to other users, empowering participation in protests, and engagement in discussions surrounding social issues (Natalia et al., 2023). However, despite many studies focusing on analyzing the content of tweets including a social movement hashtag, few studies have focused on analysing the content of tweets including a social movement hashtag, through the examination of their format, the comments, and other reactions they generate, and specifically for the Fridays for Future movement and during a specific period (lockdown produced by COVID-19). The result offers important theoretical and practical contributions for the usage and impact of hashtags on Twitter social network, specifically using the hashtag #fridaysforfuture to promote online

social movements related to environmental protection. These findings aim to provide a valuable reference for other non-profit causes and social movements. It explores how, through the hashtag, a singular message can transcend international borders, even when languages differ, and when social contact is restricted. This research sheds light on how the hashtag contribute to information disclosure and plays a crucial role in amplifying an environmentally focused social movement through online social media.

The results describe how to design a message by a famous social movement by identifying the most popular topics, what the audience is most interested in and the strategies and actions that generate the most mobilization, offering valuable insights to empower other social movements in shaping their effective social media strategies. They also highlight the importance of using hashtags to create vital communities related to social movements. In response to the research questions on tweets: "What are the main topics or types of content of tweets tagged with the hashtag #fridaysforfuture on Twitter?" and "In what formats are tweets tagged with the hashtag #fridaysforfuture posted on Twitter?", we can point out that most tweets include content related to interaction and dialogue in textual format or other hashtags related to sustainability. In line with previous studies, the use of more active forms of interactive resources such as @mention or #hashtags are common when interaction and dialogue is to be encouraged through a tweet (Nelson, 2019). Regarding the research question "What type(s) of content(s) and tweet format(s) get more reactions from users (second level, i.e. reactions related to the main tweets)?", it has been found that, the number of reactions in the form of likes, shares, and comments is higher for tweets that combine content related to action, mobilization, digital strikes and COVID-19. Likewise, the format combination that generates the most likes, shares, comments, and responses is textual information, together with other hashtags related to sustainability, digital strike and images. In this case, the type of format can be considered a way of reinforcing the content, disclosing textual information about the movement, or making calls for action or mobilization through hashtags related to the digital strike. These results make sense considering that Twitter is the best platform to facilitate dialogue, protest or encourage action and mobilization (Lynn et al., 2020; Smith et al., 2019) and that with the COVID-19 pandemic, all activities of the Friday of Future movement had to move online (Sorce & Dumitrica, 2023). In reference to the research questions on comments: "What are the main topics or types of content of comments related to tweets tagged with the hashtag #fridayforthefuture on Twitter?" and "In what formats comments related to tweets tagged with the hashtag #fridaysforfuture are published on Twitter?", the majority express their support for the movement in textual format. As for "Which content type(s) and tweet format(s) get the most reactions from users (second level, i.e. reactions related to the main tweets)?", in this case significant results were only found for the video format. The types of content or format of the comment do not seem to affect the response to the comment related to the main tweet.

The current study does have certain limitations that could be addressed in future research endeavors. One aspect involves the potential expansion of the sample size by including a greater number of tweets and other green/social movements. With respect to the external validity of the study, although Twitter is considered the most

appropriate social network to promote a social movement, it would be advisable to analyze the role that other social media platforms play in this process. Another limitation pertains to the type of data utilized, specifically cross-sectional data. Unlike this type of data, longitudinal data enable the measurement of changes over time. Furthermore, while intercoder reliability was high, refinement of coding could be achieved through the utilization of artificial intelligence tools for automatic coding. This limitation was addressed in the current study by employing multiple independent judges to ensure intercoder reliability.

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Data availability Data set associated with this paper is available upon request to authors.

Declarations

Competing interests The authors report there are no competing interests to declare.

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