

# **Historical Hashtags: An Investigation of the ‘#CometLanding’ Tweets**

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## **Abstract**

This study aims to investigate how the Twittersphere reacted during the recent historical event of robotic landing on a comet. The news is about Philae, a robotic lander from the European Space Agency (ESA), which successfully made the first-ever rendezvous and touchdown of its kind on a comet nucleus on November 12, 2014. In order to understand how Twitter is practically used in spreading messages on historical events, we conducted an analysis of one-week of tweet feeds that contain the #CometLanding hashtag. We studied the trends of tweets, the diffusion of the information and the characteristics of the social network created. The results indicated that the use of Twitter as a platform enables online communities to engage and spread the historic event through social media network (e.g. tweets, retweets, mentions and replies). In addition, it was found that comprehensible and understandable hashtags could influence users to follow the same tweet stream compared to other laborious hashtags that were difficult to understand on social media.

## **Keywords**

Diffusion of information, hashtag, social media, Twitter

## **1 Introduction**

Microblogging is a novel form of communication that involves posting updates, ideas, or simply quick notifications, thus providing a flexible platform for communication (Ebner, 2009; Zhao and Rosson, 2009) and Twitter is one of the most popular microblogging service used for spreading information. Twitter has more than approximately 1.3 billion users (as of 2016), of which, 317 million are active users (Twitter Report 2016). The site was launched on July 13, 2006 (Jansen et al., 2009) and has since expanded considerably in its use for connecting people and spreading information (Golbeck, Grimes and Rogers, 2010; Java et al., 2007). Twitter enables users to send and read short messages called ‘tweets’ with 140-characters and focuses more on small events happening in users’ daily and work activities (Arakawa et al., 2014). Twitter defined itself as “a real-time information network powered by people all around the world that lets you share and discover what’s happening now” (Twitter.com).

Hashtags, words or phrases prefixed with “#” sign are the primary way in which Twitter users organise the information they tweet and make it more searchable (Bruns and Stieglitz, 2013). The trending hashtag will appear on the Twitter sidebar when they are currently and massively used in real-time as the trending topic. Hashtag enables tweets on specific topic to be found easily by clicking on the hashtag topic or searching for the said hashtag. Hashtags make it easier for people to find and follow discussions about brands, events and promotions. In the context of events or conferences, hashtags are found to be expedient because conference organizer and participants can share information and content about the event using the same hashtag such as #iswc, #kidneywk11 and #TtW12 (Chang, 2010). According to Onook, Agrawal and Rao, a twitter hashtag archive can be considered as result of a collective effort, because the posts can be aggregated into a single stream with a common #hashtag. They also let brands track the performance of promotions across social media, as it allows you to keep track of the brands and search for updates. Although several studies have conducted Twitter research on academic conferences (Ebner, 2009; Letierce, Passant, Breslin, et al., 2010; Ross et al., 2011; Wen, Parra and Trattner, 2014; Reinhardt et al., 2009), politics and government (Mergel, 2013; Hsu and Park, 2012; Golbeck, Grimes and Rogers, 2010; Aharony,

2012; Feroz Khan et al., 2014), education (Ebner et al., 2010; Ebner and Schiefner, 2008), entertainment (Lee and Goh, 2013), and conflict (Oh, Agrawal and Rao, 2010), there has been less prior works on historical events, especially using hashtags. With this stimulus, this study is conducted to measure tweets for an historic event – the Rosetta Mission Probe landing.

On 12<sup>th</sup> November 2014, #CometLanding was trending worldwide on the Twitter platform, as Rosetta's mini-spacecraft lander, Philae, successfully made the first-ever controlled touchdown or rendezvousing with a comet, known as Comet 67P (<http://www.esa.int/ESA>). Philae is the first robot lander to successfully land on nucleus comet. Philae is controlled and tracked by European Space Operations Center (ESOC) at Darmstadt, Germany. Rosetta is a spacecraft that was launched in 2004 and has been orbiting the comet since August 2014, after ten-year journey from the Earth. It was a big day for the ESA on that date as Philae lander detached from Rosetta to make a successful rendezvous, and finally, to direct the first images from a comet's surface to the ESA space station. According to ESA, this mission represents a human-led exploration of space where the focus is to determine the composition of the comet itself and transmit data for more and future unique scientific discoveries. Centered from this event, millions tweets were disseminated and deposited by online community on social media that made the topic trending worldwide and visible on the Tagboard for many hours that day (Fig. 1). Sensing from this phenomena, this study was conducted to analyze tweets for Rosetta Mission Probe landing using the #CometLanding hashtag and see the impact of this historic event. To gain new insights in this area, this work used a dataset of tweet feeds of #CometLanding and provides in-depth analysis on the real-time dataset. The research focuses on the information diffusion and communication flowing within a one-week period of this historic event.

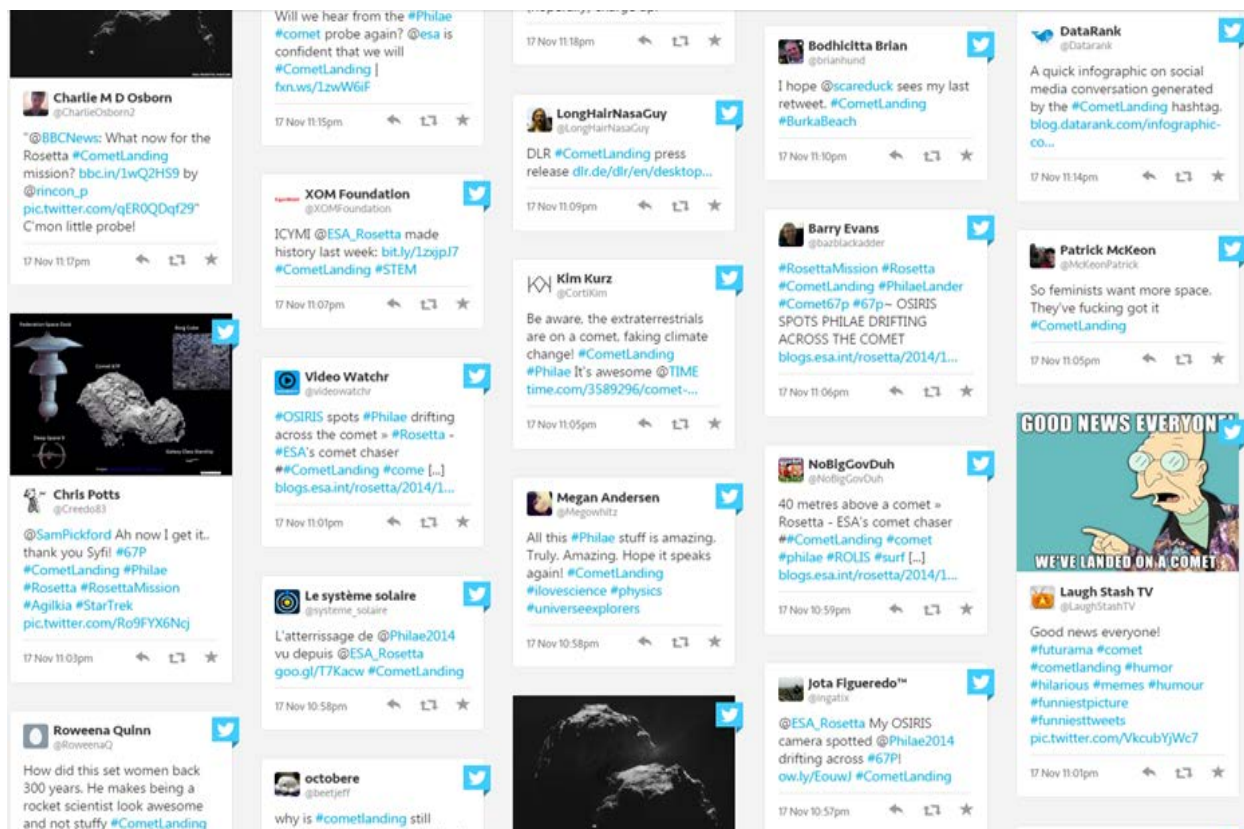


Figure 1. Screen shot from Tagboard showing the trending topic (2014)

## 2 Previous work

There have been several studies about the role of Twitter in numerous events includes academic conferences (Reinhardt et al., 2009), government and politics (Mergel, 2013; Panagiotopoulos, Bigdeli and Sams, 2012; Hsu and Park, 2012), education (Ebner et al., 2010; Ebner and Schiefner, 2008; Milstein, 2009) and business (Jansen et al., 2009) (see Table 1). For instance, Letierce, Passant, Breslin, et al. conducted a study about the usage of Twitter by the semantic web community during the 2009 Internal Semantic Web Conference (ISWC). The study discussed the

motivations that drive conference participants to tweet and analysed how Twitter was used during the event. It was revealed that wanting to share knowledge and work about their fields of expertise led participants to use Twitter and hashtags to help others find out what happening at the conference. A study by Ebner analysed tweets posted during the EdMedia conference in 2008 by conducting a survey over 41 people who used Twitter during the conference. They revealed that people who were most active on Twitter during the conference were the attendants of the conference and they participated for the purpose of resource sharing, online presence and also to communicate with peers.

Similarly, Ross et al. examined the use of Twitter as a backchannel at academic conferences within a group of digital communities. They studied the postings from three conferences in 2009 and conducted quantitative and qualitative methods for the analysis. They discovered that conference hashtag activity does not represent a single conversation but rather multiple monologues between users. In a different study, researchers examined the use of Twitter in four different computer science conferences in 2012, which covered the interactions between users in the research community, especially at academic conferences (Wen, Parra and Trattner, 2014). The study classified the users into five groups - junior researcher, senior researcher, faculty, industry and organization - and investigated how they interact and communicate in and across the groups. The findings showed that there were signs of homophily within the groups; where senior members or senior researchers in a research community have a tendency to communicate with other senior members within the same level of experiences, instead of with newcomers to the community (e.g. junior researcher).

Previous studies have shown that hashtags were frequently used in various events like conferences and political elections as such. However, we found that there has been less study of using hashtags for historic event and this becomes the motivation of this research. We limit our focus to historical event and to the best of our knowledge, this study is the first one studying about tweets of historic event hashtag: #CometLanding. The dataset enables us to draw our findings, learn how the information is diffused and the structure of the network involved.

Table 1. Use of Twitter hashtag in previous works

<b>Ref.</b>	<b>Event</b>	<b>Findings</b>
(Letierce, Passant, Breslin, et al., 2010)	8th International Semantic Web Conference - ISWC 2009	Tweets from the event help to summarise what the event is all about and keep users updated.
Ebner	Education Learning Conference - ED-Media 2008	Live micro-blogging can help and expand the conference presentation.
(Ross et al., 2011)	Digital Humanities 2009, That Camp 2009 and Digital Resources in the Art and Humanities 2009.	Tweets activity during the conferences were conducted in multiple monologues and conversations between users.
(Wen, Parra and Trattner, 2014)	Hypertext 2012, UMAP 2012, RecSys 2012 and ECTEL 2012	There are signs of homophily between the experienced groups, like senior researcher, has a tendency to interact with other similar senior members compared to junior members
(Reinhardt et al., 2009)	Five conferences	Twitter can enhance the knowledge of a given group or community
(Golbeck, Grimes and Rogers, 2010)	Twitter use by US congress members	Twitter is used to disperse information, especially links to news articles about congress members to their blogs, and to report on daily activity.
(Aharony, 2012)	US presidential 2008 Democratic Party	Twitter is used to keep followers abreast of their upcoming appearances
(Jansen et al., 2009)	Banco Santander and Jet Blue Airways	Twitter is used to promote their services and disseminate information to stakeholders.
(Milstein, 2009)	Library arena	Claimed that Twitter serves as an important channel for libraries.
(Ebner and Schiefner, 2008)	Educational tool	Microblogging should be seen as a completely new form of communication that can support informal learning beyond classrooms.

### 3 Methodology

The data utilised in this study were collected between 11<sup>th</sup> November and 17<sup>th</sup> November 2014 using Talkwalker, web crawler for academic research that generate data from Twitter API (Application Programming Interface). Then, NodeXL, an open source software for network analysis, was used to visualise what kind of networks were created on Twitter (Khan, Yoon and Park, 2014). For network analysis, the examples of variables measured were the number of tweets, tweet types, tweet time and metrics.

In order to collect the dataset, we investigated the popularity of the hashtag based on the number of tweets and the engagement levels. Our focus is to crawl and search for tweets containing the official hashtag #CometLanding within the one-week window. However, the data crawling process conducted did not include tweets from those with protected accounts. We stopped collecting data several days after the historic event took place since our focus is to explicitly crawl Twitter messages within one week of the landing timeline. A total of 801,998 tweets were posted using this hashtag (#CometLanding) during the timeline period. The one-week of tweets were collected and filtered using the following criteria:

- i. Tweets must contain hashtag associated with the historic comet land (e.g. #CometLanding)
- ii. Contains all language tweets with the correct hashtag (e.g. #CometLanding)
- iii. Includes all tweets, retweets, replies and mentions

To determine the distribution of our datasets, we distinguished tweets from retweets. Retweeting has been extremely popular because of its straightforwardness and the automated retweet button available for Twitter user (Aharony, 2012). Retweet also known as an important feature in disseminating information on social media. In fact, retweeting practice contributes to a conversational ecology where conversations are composed publicly and drive an emotional sense of shared conversational context (Boyd, Golder and Lotan, 2010). With this in mind, we analysed the syntax of retweets, how people retweet, why they retweet, and what they retweet, in this study. Moreover, in line with studies from Letierce, Passant, Breslin, et al. (#isw2009) and Desai et al. (#kid-neywk11), analysis was performed in three different ways: the structure of tweets, how tweets are diffused, and the social networking that exists.

## 4 Findings

### 4.1 Statistical Descriptive Analysis

In terms of gender involvement, 71.3% male and 28.7% female were found tweeted using the hashtag. For media types, 99.1% results were found from Twitter, followed by online news (0.42%), Facebook (0.20%), blogs (0.11%), newspaper (0.08%), forums (0.06%) and others (0.07%). We also extracted tweets demographic that is, the results of tweets according to country, as depicted in Fig. 2. Based on the world map demographics, most tweets originated from the US (389,462 tweets), followed by UK (102,782 tweets) and Germany (44,685 tweets). The percentage shows that users from the US were actively using and interacting on Twitter at that time.

Next, Table 2 shows the breakdown level of buzz, engagement and reach of the tweets during the event. Buzz represents the noise that the hashtag have generated online during that period, engagement means the sum of actions (e.g. number of retweets) made by others on the tweets that mentioned the hashtag and reach means the number of people who were reached by the hashtag tweets (e.g. the number of followers of the author of the tweets). The table indicates that the majority of tweets took place on November 12, 2014 with 536,710 tweets, 458,630 engagements (number of retweets) and the potential of the tweets to reach approximately 2.9 billion followers. These figures show that the #CometLanding hashtag was the most expanded by Twitter users on that day. Next, when we looked at the sentiment of tweets, we can see that 61.8% (495,800) tweets were neutral tweets, followed by 28.2% (226,000) positive tweets and 10% (80,000) negative tweets. The examples of the tweets that we encountered for each category are as follows:

- Neutral tweets: “Finally! I’m stretching my legs after more than 10 years. Landing gear deployed! #CometLanding “ - @Philae2014
- Positive tweets:”@Philae2014 You’ve done a great job Philae, something no spacecraft has ever done before. #CometLanding” - @ESA\_Rosetta
- Negative tweets: “I’m in the shadow of a cliff on #67P. Where exactly? That’s what my team is in the process of finding out! #CometLanding” - @Philae2014.

Then, we computed the engagement of the influencers in this event to identify the most influential influencers and understand their impact. To identify this, we collected tweets from top influencers with the number of reach and engagement derived from their tweets (see Table 3). The statistic reveals that the top influencer in this event was @Philae2014





Figure 2. The demographic world map

Table 2. Buzz vs Engagement vs Reach

Date	Buzz	Engagement	Reach
11/11/14	14,059	12,198	145,583,139
12/11/14	536,710	458,630	2,972,014,124
13/11/14	136,116	92,360	719,347,706
14/11/14	46,920	35,525	304,782,117
15/11/14	49,722	38,873	166,422,174
15/11/14	8604	3716	25,255,418
17/11/14	9867	7774	60,323,178
<b>Total</b>	<b>801,998</b>	<b>646,076</b>	<b>4,393,727,856</b>

## 4.2 Difussion of hashtag analysis

We examined the pattern of tweets over time using this hashtag in our dataset and the timeline tracking shows explicitly when the event took place and at what pace. Fig. 3 shows that there were fewer tweets one day before the scheduled landing, but reached its peaked the moment Philae literally landed on the comet on November 12, 2014 at 17:00 UTC with 191,761 tweets. We also identified several pikes in response to the hashtag at 17:05, 17:06 and 17:10 observing the number of tweets per minute. We perceived that majority of the tweets were sent when Philae successfully landed. The most retweeted tweet at that time was from user @Philae2014 when it announced the touchdown on November 12, 2014 at 17:04 pm UTC as:

“Touchdown! My new address: 67P! “CometLanding”

Table 4 represents the list of users with the highest retweets during the one-week event. Essentially, there is no universally consistent syntax used to indicate a retweet in precise, as the attribution is inconsistent, the characters are limited and also the prompt alteration from users as they retweet (Boyd, Golder and Lotan, 2010). Therefore, we set our focused on users who retweeting directly using the button and also users who used other retweet syntax and styles. We found that it was relevant as long as the message reached the intended audience. The examples of retweet styles are to copy the message, precede it with RT, or address the original author (e.g. RT #CometLanding”). The examples of tweet and retweet that we discovered during this study are as follows:

- Tweet: The view is absolutely breath taking ESA\_Rosetta! Unlike anything I've ever seen [#CometLanding pic.twitter.com/flsSdxz0bo](https://pic.twitter.com/flsSdxz0bo) by @Philae2014
- Retweet: “@Philae2014: The view is absolutely breathtaking ESA\_Rosetta! Unlike anything I've ever seen [#CometLanding pic.twitter.com/flsSdxz0bo](https://pic.twitter.com/flsSdxz0bo)” by @Karl\_Svensson

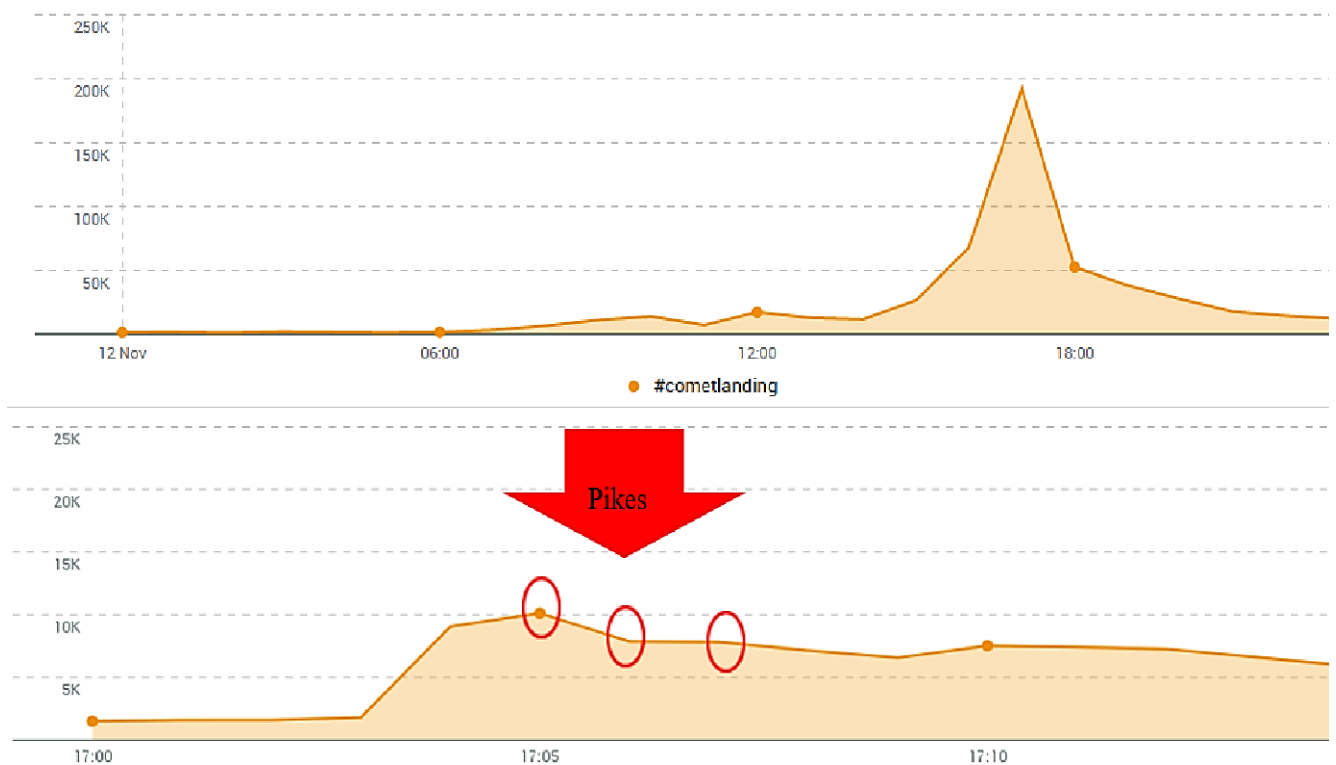


Figure 3. The pattern of #CometLanding tweets over time during the historic event, November 12, 2014

Table 3. Top Influencers

Rank	Influencer	Reach	Engagement	#Followers
1	Philae Lander (@Philae2014)	7.7m	138k	78k
2	ESA Rosetta Mission (@ESA_Rosetta)	15.7m	82.3k	155.7k
3	ESA Operations (@esaoperations)	15.2m	35k	79.3k
4	BBC Breaking News (@BBCBreaking)	254m	24.3k	12.2m
5	ESA (@esa)	45.8m	15.9k	298k
6	NASA (@NASA)	254m	12.7k	8.02m
7	Observing Space (@ObservingSpace)	11.6m	11k	43.3k
8	Emily Lakdawalla (@elakdawalla)	9m	5k	60.4k
9	ESA Science (@esascience)	8.8m	4.8k	104k
10	Mashable (@mashable)	99.5m	4.4k	4.76m

Table 4. Example of original tweets and retweets

Username	Message	Retweets
@Philae2014	Touchdown! My new address: 67P! #CometLanding 12/11/14   Twitter   United States	36.1k retweets
@ESA_Rosetta	TOUCHDOWN for @Philae2014 !#CometLanding pic.twitter.com/ZMB8ng3h 12/11/14   Twitter   United States	19.2k retweets
@Philae2014	Now that I'm safely on the ground, here is what my new home #67P looks like from where I am. #CometLanding..	15.5k retweets



Figure 4. Themes dissemination

Based on the analysis, we also found that our dataset contains between 7 % retweets and 46 % retweets with the hashtag #CometLanding depending on the tweet messages. This distribution is consistent and aligned with a study where the hashtag retweets pertaining to scientific data were around 15 % to 42 % (2010). However, this distribution differs with studies on general Twitter data where retweets can be as low as 5 % for general data (Boyd, Golder and Lotan, 2010). In addition, the comet landing that we conceptualised as a historic event gained a lot of attention from both offline and online communities. During this event, Twitter users created a lot of hashtags that represented the historic event, as shown in Fig. 4. #CometLanding was found to be the most popular hashtag with more than 801,000 hits followed by Philae2014 and @Philae2014.



Figure 5. Network of CometLanding

### 4.3 Social network analysis

In this section, we conducted network analysis to examine communication patterns on Twitter during this event. It involves different types of communication such as hashtags, mentions, replies and tweets as studied by Lin et al. and Wen et al.. For this analysis, we crawled one-week conversations and retweets that contain #CometLanding from Twitter using NodeXL to obtain a comprehensive dataset. In the network visualisation, nodes represent users and the

edge or link between the nodes shows the connection that occurs, such as through retweets or mentions. For this analysis, we examined the network by measuring the number of nodes, the number of edges, reciprocity, the degree, and the clustering coefficient of the network. Fig. 5 shows the network visualisation that depicted the flow of communication during this one-week event. There were 604 number of nodes with 802 unique edges involved in this network. The first observation is the degree of reciprocity in this network where the ratio of the number of relations which are reciprocated over the number of total relations in the network is measured. We found low *reciprocity* (0.005) in this network, which was expected as Wen et al. also found in their study that retweeting activity contributes to low degree of reciprocity in a network due to lower interactions. Then, the node's *clustering coefficient* (0.011) was found to be significantly low in this network. The clustering coefficient is the number of closed triplets in a neighbourhood or the degree to which nodes in a network tend to cluster together. It indicates that the network has minimum clustering and was more likely to perform disjointed cliques. This was supported through our last observation on number of *in-degree* (i.e. incoming connections) and *out-degree* (i.e. outgoing connections) in the network. The average number of in-degree and out-degree connections is similar in this network, which is 1.328. Below are examples of communications that occurred in the network between the nodes:

- Tweet: **Philae Lander** @Philae2014 Nov 13  
"I'm in the shadow of a cliff on #67P. Where exactly? That's what my team is in the process of finding out! #CometLanding"
- Reply: **ESA Rosetta Mission** @ESA\_Rosetta Nov 13  
"@Philae2014 you're in a shadow? How am I supposed to spot you there?! Our teams working hard to find you"
- Reply back: **Philae Lander** @Philae2014 Nov 13  
"Phew! @ESA\_Rosetta I am confident that our teams will find me. Wouldn't like to lose touch with you. #CometLanding"

## 5 Discussion and Conclusion

In this study, we analysed Twitter feeds for the Rosetta Mission Probe landing. Our analysis revealed that most users chose to adopt an uncomplicated and easy official hashtag because it is more understandable and comprehensible. We found that the #CometLanding hashtag received the most hits 801,998 compared to other additional trending hashtags, such as #67P and #Rosetta. It shows that users compliantly tend to follow the hashtag stream and applied the hashtag started by the initiator or domain user. From our observation, user behaviour of tagging is mostly about complying with and adopting this simple hashtag: #CometLanding. Essentially, there was other an additional hashtag used by some people, which is #67P. Even though #67P -the scientific name of the comet- is short and precise compared to other hashtags, but this hashtag did not trend. Based on our insight, this kind of hashtag is more likely perceived as a technical tag because first, the public have no idea of what 67P represents and only those who are familiar and aware of space terms tended to use this hashtag, since it requires a certain level of knowledge and awareness of what it implies. With a simple hashtag, such as #CometLanding, users were quickly settled on the hashtag and we can conclude that it directly attracted people to tweet and engage disseminating information collectively.

Secondly, our findings suggest that Twittersphere is a suitable platform for disseminating information for historic events based on the amount of the potential reach tweets calculation during this event. This indicates that microblogging is an important source of covering real-time news updates for an event like this and has a broader network of coverage compared to other social media forms, such as Facebook. Users can easily access the hashtag since any trending topic on Twitter will be displayed on the left side of the client page. They can follow the stream of news updates and post comments to the hashtag without needing to establish a mutual follower/followee relationship with the original posters. This kind of approach spreads the richness of the event and makes the tweets visible for other users who are regularly viewing and gaining updates through hashtags. Besides, several conversations and interactions between two top influencers' account (@Philae2014 and @ESA\_Rosetta) were found appealing to followers, and as a result, attracted many users to retweet and favoured their interactions. It can therefore be assumed that this appealing interaction contributed to the high level of engagement identified during the event.

Our analysis also supports suggestions that influencers play an important role as a driving factor to encourage followers to engage. Our analysis showed that users like @Philae2014 and @ESA\_Rosetta are the top influencers and that these users are likely the people who were directly, physically and virtually involved in the event. We also found that the frequency of tweets from the influencer (e.g. @Philae2014) was higher when the landing happened with around one tweet per minute (within 10 minutes of the landing) compared to other days within the study period.



This suggests that influencers used this strategy to keep updating their followers by giving and sharing the latest information to maintain engagement, and at the same time ensuring #CometLanding continued trending on the first page of Twitter. We can infer that these frequent tweets held people's attention and encouraged them to follow updates of this historic event and this resulted in the propagation of information across other online communities.

However, there are some limitations on this work. For a start, we conducted our analysis during a one-week time frame, but the results might not be generalizable to the period before and after the event since situations may be different. For future work, our recommendation is to examine the usage of additional tags related to the domain hashtag that may enable the spread of messages outside the initial online community. Further, research is needed to future investigate and validate the suitability of Twitter for historic events compared to other social media types.

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## Biography

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**Christopher Durugbo** was a Lecturer of Management in School of Economics, Finance and Management at the University of Bristol. His research areas include systems and network analysis, service operations management, engineering design, information and technology management, and human factors. The findings from his research with academic and industrial collaborators have been accepted for publication in several journals such as *Expert Systems with Applications*, *International Journal of Production Research*, *Production Planning and Control*, *Ergonomics*, *Information Sciences*, *International Journal of Technology Management*, *The Service Industries Journal*, *International Journal of Information Management*, *Business Process Management Journal*, *Systems Engineering*, *International Journal of Advanced Manufacturing Technology*, and *Journal of Intelligent Manufacturing*. He has also presented his research outcomes at international conferences with proceedings that have been published by associations such as *Euroma*, *INFORMS*, *Euro*, *Springer*, the *Institute of Electrical and Electronics Engineers* (IEEE) and the *College International pour la Recherche en Productique* (CIRP).