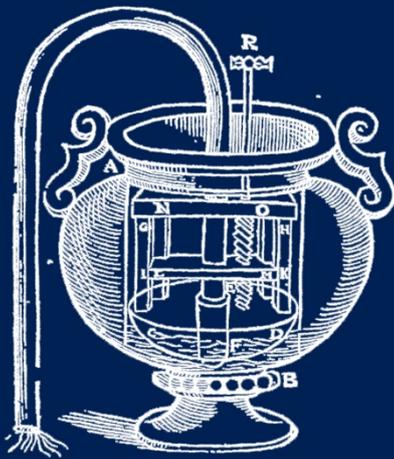


# CNR-IRCrES Working Paper

**Innovation and communication  
of companies on Twitter before  
and during COVID-19 crisis**



8/2020

**José N. Franco-Riquelme**

**Antonio Zinilli**

**Joaquín B. Ordieres-Meré**

**Emanuela Reale**

*Direttore* Emanuela Reale

*Direzione* CNR-IRCrES  
*Istituto di Ricerca sulla Crescita Economica Sostenibile*  
Via Real Collegio 30, 10024 Moncalieri (Torino), Italy  
Tel. +39 011 6824911 / Fax +39 011 6824966  
segreteria@ircres.cnr.it  
www.ircres.cnr.it

*Sede di Roma* Via dei Taurini 19, 00185 Roma, Italy  
Tel. +39 06 49937809 / Fax +39 06 49937808

*Sede di Milano* Via Bassini 15, 20121 Milano, Italy  
Tel. +39 02 23699501 / Fax +39 02 23699530

*Sede di Genova* Università di Genova Via Balbi, 6 - 16126 Genova  
Tel. +39 010 2465459 / Fax +39 010 2099826

#### **Comitato Redazione**

Emanuela Reale, Giuseppe Giulio Calabrese, Grazia Biorci, Igor Benati, Antonella Emina, Serena Fabrizio, Lucio Morettini, Susanna Paleari, Anna Perin, Secondo Rolfo, Isabella Maria Zoppi.



[redazione@ircres.cnr.it](mailto:redazione@ircres.cnr.it)



[www.ircres.cnr.it/index.php/it/produzione-scientifica/pubblicazioni](http://www.ircres.cnr.it/index.php/it/produzione-scientifica/pubblicazioni)

The Working Papers published by CNR-IRCrES represent the views of the respective author(s) and not of the Institute as a whole.

CNR-IRCrES Working Paper 8/2020



ottobre 2020 by CNR-IRCrES

# Innovation and communication of companies on Twitter before and during COVID-19 crisis

---

JOSÉ N. FRANCO-RIQUELME<sup>a</sup>, ANTONIO ZINILLI<sup>b</sup>, JOAQUÍN B. ORDIERES-MERÉ<sup>a</sup> AND EMANUELA REALE<sup>b</sup>

<sup>a</sup> Department of Industrial Engineering, Business Administration and Statistics, Universidad Politécnica de Madrid (UPM), 28006, Madrid, Spain

<sup>b</sup> Research Institute on Sustainable Economic Growth (IRCrES), Consiglio Nazionale delle Ricerche (CNR), 00185, Roma RM, Italy

corresponding author/s: [j.franco.riquelme@upm.es](mailto:j.franco.riquelme@upm.es)

## ABSTRACT

We address the diffusion of information about the innovation before and during COVID-19 emergency with extensive data analysis on Twitter. We examine Italian and Spanish companies engaged in ICT, automotive, and pharmaceutical fields to understand how the message on innovation has changed. Furthermore, we observe the evolution of the discourse on a global scale, also considering the feedback of their users' retweets, likes, etc. We used web scraping approaches to retrieve the information on the platform, and we analysed the data through text mining, and complex system approaches. Making the period between the year 2019 – previously the outbreak – and during COVID-19 pandemic as balanced as possible, we extrapolated the data from December 31, 2019, to May 4, 2020. In this work, we provide an in-depth analysis of the dynamics of communication in a time window in which narratives and moods in social media due to COVID-19 have emerged and spread. In this work, we also performed a comparative analysis of messages (in three different languages: Italian, Spanish, and English) elaborated by companies localised in Spain and Italy.

KEYWORDS: COVID-19, Coronavirus, pandemic crisis, innovation, text mining, Twitter.

JEL codes: F23, M00

DOI: 10.23760/2421-7158.2020.008

## HOW TO CITE THIS ARTICLE

Franco-Riquelme, J.N., Zinilli, A., Ordieres-Meré, J., & Reale, E. (2020). *Innovation and communication of companies on Twitter before and during COVID-19 crisis* (CNR-IRCrES Working Paper 8/2020). Istituto di Ricerca sulla Crescita Economica Sostenibile. Disponibile da <http://dx.doi.org/10.23760/2421-7158.2020.008>

---

INDICE/CONTENTS

|       |   |    |
|-------|---|----|
| 1     | INTRODUCTION.....                       | 3  |
| 2     | BACKGROUND .....                        | 4  |
| 2.1   | Research questions and hypotheses ..... | 5  |
| 3     | METHODS .....                           | 6  |
| 3.1   | Sample selection .....                  | 6  |
| 3.2   | Pre-processing.....                     | 7  |
| 3.3   | Data analysis .....                     | 8  |
| 3.3.1 | Text classification.....                | 8  |
| 3.3.2 | Bag of Words.....                       | 8  |
| 4     | RESULTS .....                           | 9  |
| 4.1   | Frequency of terms .....                | 9  |
| 4.1.1 | ICT companies .....                     | 9  |
| 4.1.2 | Automotive companies .....              | 11 |
| 4.1.3 | Pharmaceutical companies .....          | 13 |
| 4.2   | Terms correlation.....                  | 15 |
| 4.3   | Trends by sectors .....                 | 17 |
| 4.4   | Activity comparison.....                | 18 |
| 5     | DISCUSSION.....                         | 19 |
| 6     | REFERENCES.....                         | 21 |

## 1 INTRODUCTION

During 2020 the pandemic crisis over the world has marked the communication in traditional and digital media, Governments, companies and social media. In this situation, all organisations faced a new perspective with overwhelming, competing challenges and uncharted waters as they continue to navigate the impacts due to this emergency. Among the more innovative-intensive sectors, we found the ICT, automotive, and pharmaceutical, where companies are involved in a broad range of related activities from product and process to marketing and organisational innovations (OECD, 2011).

The termed coronavirus disease 2019 (COVID-19) is defined as an illness caused by a new coronavirus that now is called: *severe acute respiratory syndrome coronavirus 2* (SARS-CoV-2), which was identified amid an outbreak of respiratory illness cases in Wuhan City, Hubei Province, China<sup>1</sup>. On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic, its first such designation since reporting H1N1 influenza an epidemic in 2009<sup>2</sup>.

Even before COVID-19, many organisations faced considerable challenges, and innovating in areas such as IT, artificial intelligence, social media analysis, etc. pushed forward the new technology for the strength to succeed. Now, COVID-19 is forcing companies to operate in new ways rapidly, and IT is being tested as never before.

The negative consequences of this crisis for many companies and sectors are still difficult to quantify accurately, considering that is no merely a sanitary issue, but a societal one, impacting the population one way or another (Rajan et al., 2020). Therefore, society, in general, from Governments to individuals, is looking at how to mitigate the impact of the post-COVID-19 era.

However, times of uncertainty can also be an occasion for innovation, sustainable growth strategies, and a new commitment to society (Martin-Rios, 2020). In this perspective, social media and especially Twitter could be a barometer or an ideal platform to research in reality caused by the pandemic crisis in corporative communication.

Social media and innovation are tightly interconnected (Brandtzaeg & Følstad, 2016). Twitter has been increasingly used by organisations as a way to increase relationships with users and for speeding up the information during shocks (Twitter, 2013). In traditional communication processes, the roles among the involved parts (sender and receiver) are distinct, and the parts pursue widely separated interests (Hoffman & Novak, 1996; Stern, 1994). In the so-called microblogs, where the communication is much more interactive and complex (in terms of rapidity and frequency of relationships), the parts change roles constantly through the sharing of messages. The two-way nature of Twitter makes its effective communication channel with the users' engagement by enabling companies and users to interact (Tsimonis & Dimitriadis, 2014).

Notably, we considered the impact of massive data in the field of communication that can be measured in quantitative and even qualitative terms. The emphasis according to the changing situation, the society where companies are immersed in order to comprehend the hidden structures under hundreds, or thousands of posts in Twitter, as a case study (Xifra, 2020). Furthermore, discover tendencies, insights and analytical outputs, associations, and correlations might find interesting information or even predict the behaviour of the analysed entities.

To address the investigation involved to the response of the society, but focused on specific sector or organisations, we take into consideration the following general questions, based on Xifra work: How to interpret the organisational communication and crisis communication of individual companies in times of the coronavirus on a platform like Twitter? What is the role of public relations and strategic communication in this pandemic, and if there are clues that can indicate us through actions related to innovation? This paper addresses exclusively the analysis of tweets, because in this kind of social media the communication is composed of short and quick messages, as well as it is not limited to a specific cluster of users (unlike Facebook). This makes it the most

<sup>1</sup> See: [https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html?CDC\\_AA\\_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fabout%2Findex.html](https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fabout%2Findex.html)

<sup>2</sup> See: <https://www.nytimes.com/2020/03/11/world/coronavirus-news.html#link-682e5b06>

appropriate tool to communicate during unexpected events. The information exchange allowed by Twitter in addition to quick communication provides an opportunity for companies for creating openings for the support of innovation in both social and marketing frameworks (Pérez-González et al., 2017).

In this study, we have focused on Italian and Spanish companies of three specific sectors, such as ICT, automotive, and pharmaceutical, to understand how the message on innovation has changed. Especially in the first phase, among the countries, Italy and Spain experiences the worst situation in Europe. To implement the analysis in these organisations, we conducted a text mining approach to identify their discourse regarding COVID-19 and innovation in two periods. Moreover, we focused on a quantitative method based on data analysis from social media. The present work is the first approach to prepare our proposal to conduct a Machine Learning (ML) analysis on Twitter companies' accounts.

This article is organised as follows. In the next section, the background section briefly describes the references about the domains studied, and it is designed the hypotheses and research questions. The methods section describes the models applied through ML techniques, performed to our data collection of tweets. Subsequently, the results of the quantitative approach conducted through the application of text analytics. In the results section, we present our approach performed to the companies analysed in three areas. Finally, a discussion is shown in the last section.

## 2 BACKGROUND

The unprecedented crisis, derived from the COVID-19 outbreak affected nations in their health system, their economies, travel, and tourism, cope with the staggering levels of unemployment, and many more aspects (McNutt, 2020). In addition to the challenges during the pandemic crisis, innovation stakeholders, and organisations find themselves abruptly involved in new relations, with other firms or new concerns before the pandemic (Tietze et al., 2020). In this tessiture, “innovation will have an important role to play in recovering from the aftermath of the coronavirus” (Chesbrough, 2020).

Due to lockdown measures over the world, people were forced to be out of public spaces, but communications about these phenomena now occur on social media platforms like Twitter (Chen et al., 2020). Social media has become flooded with content connected with the virus, and perhaps no other platform consistently performs a more notable role in the medical world than Twitter (Rosenberg et al., 2020). As an example, one of the first mention regarding the outbreak it can be traced in the early January of 2020 (see **Figure 1**).

**Figure 1.** The first mention of a new illness on Twitter from WHO



Source: WHO Twitter account.

From the example above, we can observe two important characteristics using Twitter: concise messages and hashtags use. Hashtags represent the main way in which users arrange the content they tweet (Hsia-Ching, 2010).

The current pandemic crisis leads many companies to modify their communication strategy to find the right timing to spread their messages without offending the general moods; companies need to be sensitive and limit their normal mandates. In changing scenarios, organisations that implemented an open innovation (OI) strategy made it possible to adjust their internal as well as external knowledge sources (which include the communication approach), to adapt to the new circumstances of a dynamic world (Vanhaverbeke et al., 2017).

Innovation in a company context indicates something new in terms of product, markets, and organisational models (Hitchen et al., 2017). Besides, innovation is considered an indicator of resilience; the most innovative companies tend to face and adapt to different crises (Linnenluecke, 2017). In the past, many companies reacted to the crisis (e.g., in 2008 financial crisis) boosting a positive business climate for innovation.

Many companies have started promoting their products on Twitter through photos, videos, and web pages (Mount & Martinez, 2014). Social media communication by companies can influence the way investors and users see it (Investis, 2015), as well as to the pursuit of obtaining information to stay innovative. Companies use social media to interact with their users in the process of innovation by proposing new ideas getting add value (Orange, 2011).

In addition, Simula et al. (2013) found that some firms showed a level of hesitancy to adopt social media tools, in particular in the first phase of social network spreading. Among the reasons for this hesitancy, there are security risks (e.g., corporate espionage), misinformation and misinterpretation of messages (Mehmet & Clarke, 2016).

There are still not many studies on the use of microblogs on the innovation aspect (Dobele et al., 2015). Among these few studies (Chen et al., 2012) highlighted the limited understandings of the value of using social networks in innovation processes.

He & Wang (2016) explore how social media, in general, can be used in the different phases of the innovation process. A common opinion of the mentioned authors is that the companies have to select appropriate communication strategies to stimulate the users to follow their messages on a platform like Twitter. All the more so during a crisis, the communication of innovation requires to be well managed as it is the spread of COVID-19 threatens to stop the innovation that has been accumulated in recent years.

## 2.1 Research questions and hypotheses

The paper studies two overarching questions:

**RQ1:** *How social communication using Twitter change because of COVID-19 pandemic?*

Derived from the **RQ1**, we formulated the following five questions and its respective hypothesis:

1. *Is there a difference in the frequency of companies' tweets between pre and during COVID-19 crisis?*  
**H1:** we anticipate that the dynamics are the same between pre and during COVID-19. We expect ups and downtrends about the frequency of posts with a longer period of non-activity by companies in the early part of the pandemic (as mentioned before the companies show to be sensitive and limit their normal mandates).
2. *Are the hashtags used more frequently during the crisis than the pre COVID-19?*  
**H2:** the hashtag is used to index words on Twitter. The hashtag allows searching for similar tweets on Twitter. This makes it easier for people to follow topics and events. For this reason, we think hashtag appear more frequently during COVID-19.
3. *Is the company's name mentioned fewer times on Twitter during the crisis?*  
**H3:** we expect that during the crisis companies show less self-reference in communication. Many companies in a time of crisis want to keep a low profile on matters related to the company.
4. *Is there a greater appeal to pictures during the crisis than the pre COVID-19?*  
**H4:** pictures, images and video are used to give more information. Using photos is a way to connect with users and keep the focus on the company. We highlight the low profile of

the companies during the crisis, and we expect fewer photos than the pre COVID-19 period.

5. *Do the presence of words are related to COVID-19 increase tweets?*

**H5:** we expect more interactions (likes and replies) when there are words related to COVID-19.

**RQ2:** *How far the content of communication through social media emphasize radical changes?*

And an independent question related to innovation during the pandemic crisis:

**IRQ:** *How much the word “innovation” is used during the COVID-19 emergency?*

**H:** innovation is little mentioned in general; however, less for pharmaceutical companies, which instead during the pandemic period play an important role (e.g., vaccines or treatments that target the infection).

Answering these research questions will give a deeper understanding of companies' communication during a crisis.

### 3 METHODS

In this section, is introduced the steps of data retrieval and the methodology needed to be employed for the case study. This phase started, scrapping the data coming from companies of three different fields.

#### 3.1 Sample selection

We performed our social media analysis in two periods, the first period before the COVID-19 crisis that comprised the year 2019. In the second period, we covered since the WHO initially reported the outbreak on December 31, 2019<sup>3</sup>, till May 4, 2020, the day of the end of Phase 0 when the Italian Government eased lockdown measures<sup>4</sup>. The analysis has been applied to Twitter accounts of selected forty-five organisations, from Italy and Spain. In Table 1 are listed the companies, their activity, and the number of tweets retrieved during the research period.

In this task, the objective is to take into account the discourse of companies before and during the pandemic crisis, filtering by each company, and retrieving information of each Twitter account based on a frequency scale. In social media analysis, these accounts provided the keywords for classifying the messages related to COVID-19 and innovation. Accordingly, we followed how Twitter and its users broadly identified the conversation regarding these topics – that is, the Twitter usernames. Data were collected from a sample of 23,221 public tweets retrieved using the Twitter Scraper in Python computer language; our database was built.

---

<sup>3</sup> See: <https://www.who.int/news-room/detail/27-04-2020-who-timeline---covid-19>

<sup>4</sup> See: <https://www.romeing.it/italy-phase-two-coexisting-with-the-coronavirus/>

**Table 1.** The forty-five companies selected

| #            | Company name | Activity       | Number of tweets |          |
|--------------|--------------|----------------|------------------|----------|
|              |              |                | Before           | Outbreak |
| 1            | ICT1         | ICT            | 584              | 244      |
| 2            | ICT2         | ICT            | 742              | 73       |
| 3            | ICT3         | ICT            | 366              | 445      |
| 4            | ICT4         | ICT            | 500              | 307      |
| 5            | ICT5         | ICT            | 297              | 69       |
| 6            | ICT6         | ICT            | 496              | 323      |
| 7            | ICT7         | ICT            | 263              | 58       |
| 8            | ICT8         | ICT            | 235              | 588      |
| 9            | ICT9         | ICT            | 161              | 105      |
| 10           | ICT10        | ICT            | 561              | 245      |
| 11           | ICT11        | ICT            | 272              | 56       |
| 12           | AUT1         | Automotive     | 129              | 18       |
| 13           | AUT2         | Automotive     | 143              | 17       |
| 14           | AUT3         | Automotive     | 613              | 121      |
| 15           | AUT4         | Automotive     | 111              | 27       |
| 16           | AUT5         | Automotive     | 112              | 37       |
| 17           | AUT6         | Automotive     | 360              | 62       |
| 18           | AUT7         | Automotive     | 103              | 25       |
| 19           | AUT8         | Automotive     | 332              | 111      |
| 20           | AUT9         | Automotive     | 122              | 35       |
| 21           | AUT10        | Automotive     | 321              | 96       |
| 22           | AUT11        | Automotive     | 591              | 145      |
| 23           | AUT12        | Automotive     | 557              | 209      |
| 24           | AUT13        | Automotive     | 453              | 107      |
| 25           | AUT14        | Automotive     | 547              | 265      |
| 26           | PHA1         | Pharmaceutical | 155              | 57       |
| 27           | PHA2         | Pharmaceutical | 159              | 35       |
| 28           | PHA3         | Pharmaceutical | 378              | 85       |
| 29           | PHA4         | Pharmaceutical | 610              | 202      |
| 30           | PHA5         | Pharmaceutical | 200              | 21       |
| 31           | PHA6         | Pharmaceutical | 582              | 222      |
| 32           | PHA7         | Pharmaceutical | 82               | 18       |
| 33           | PHA8         | Pharmaceutical | 668              | 175      |
| 34           | PHA9         | Pharmaceutical | 425              | 73       |
| 34           | PHA10        | Pharmaceutical | 613              | 225      |
| 36           | PHA11        | Pharmaceutical | 173              | 49       |
| 37           | PHA12        | Pharmaceutical | 141              | 28       |
| 38           | PHA13        | Pharmaceutical | 482              | 115      |
| 39           | PHA14        | Pharmaceutical | 669              | 136      |
| 40           | PHA15        | Pharmaceutical | 387              | 136      |
| 41           | PHA16        | Pharmaceutical | 368              | 107      |
| 42           | PHA17        | Pharmaceutical | 408              | 149      |
| 43           | PHA18        | Pharmaceutical | 470              | 376      |
| 44           | PHA19        | Pharmaceutical | 323              | 139      |
| 45           | PHA20        | Pharmaceutical | 625              | 196      |
| <b>Total</b> |              |                | <b>23,221</b>    |          |

### 3.2 Pre-processing

To perform text mining, we first chose tweet dates to define the periods under study, and after that, we focused on the text, extracting all the information for our analysis based on the tweets.

The Natural Language Processing (NLP) approach is performed for cleaning the text from the tweets, and to establish the corpus, which can be defined as a collection of texts that is representative of a particular natural language (Xiao, 2010). In particular, the observable data can be traced, where the corpus represents the database that is acquired for the language study (Tognini Bonelli, 2010).

The pre-processing phase is described according to the following NLP steps (Jurafsky & Martin, 2008):

- Regular expressions (RE): These consist of the standard notation for characterising text sequences. For this research, we used RE for information retrieval applications and text search strings. RE became a particularly useful tool for finding patterns in Twitter corpus and identifying and extracting them – for example, `pic.twitter.com/ (.*)`, `(RT | via) ((?:\b\W*\@\w+)+)`.

- Normalisation: The text needs to be coherent, unifying the same terms, whether they are written in different formats or languages. Within the same data collection process, there are traits, which may differ depending on the location.

- Tokenisation: This refers to words or tokens, and in this case, they are separated by white spaces, sentences, usually by certain kinds of punctuation (periods, question marks, and exclamation points). Each tweet is considered a sentence, and the tokens within it provided us with useful information.

- Filtering: This refers to refining text containing odd characters and removing hashtags or Twitter jargon, such as “RT” (which means retweet), also self-mentions, and emoticons, among other particular types.

- Additional pre-processing: This constitutes secondary tasks such as eliminating repeated words or characters, numbers, and blank spaces, correcting the grammatical errors in the post, and converting the entire text to lowercase.

In addition to these steps, we omitted some NLP tasks to achieve the best performance during further text analysis. Techniques such as part of speech (POS) tagging, stemming, and lemmatisation are among them. Besides, some words had no information value; these are called stopwords (i.e., “he,” “they,” “of,” and so on).

### 3.3 Data analysis

Once the text collection is ready for analysis, this stage is considered critical to obtain valuable information to modelled performing ML techniques. Having built our database on the key terms associated with COVID-19 and innovation, the time definition, text cleaning, and tweets classification, our analytical approach starts. For this stage, we used R, which is a free software environment for statistical computing and graphics, that allowed us to carry out the core research.

#### 3.3.1 Text classification

A collection of sentences consists of words, and in the area of linguistics and probability, and N-gram is a contiguous sequence of N words from a given sample of text. Here it is described our research implementation to extract the features from data.

- Unigrams: The one-word representation, to be used for terms frequencies.

- Bigrams: The two-word cluster used to capture more context, in general, instead of a single word (unigram).

Once categorised the vast amount of words resulted from the extraction procedures, it is established a set of techniques to deal with the information behind to be extracted through the quantitative approach. According to Tognini Bonelli (2010) the “quantitative element (frequency of occurrence) is considered very significant and, depending on the specific approach, is taken to determine the categories of description.”

Likewise, the terms resulting from the classification can be correlated, obtaining an indication of proximity with other words, in order to get hold of a list based on a correlation coefficient.

#### 3.3.2 Bag of Words

The information retrieval (IR) method is best represented concisely with the help of visualisation tools. Hence, the Bag of Words (BoW) model is a simplified version of the NLP

approach. The BoW model represents a multiset of words, which could be divided by unigrams or bigrams.

Furthermore, The most used representations of BoW are the “frequency charts” and “wordclouds.” The former one consists of it to count the most mentioned terms and show the scale based on its repetition. In fact, Liu et al. (2005) proposed the assignment of the recurrence words found in the comments as a central aspect of the opinion, comprehending this a basic procedure, but effective representation of opinion mining. In the latter one, the position of terms indicates how it is connected, and according to the size, its magnitude of importance in a form depicted as a cloud (Nulty et al., 2016).

## 4 RESULTS

In the analysis of data retrieved from Twitter regarding the forty-five companies, we obtained notable outcomes as a first exploratory approach. This research allowed us to compare and remark on their discourse in two periods, showing perceptions on how they communicate before and during the pandemic crisis with a focus on innovation and COVID-19, and the terms that they used more frequently.

Once we obtained and processed the results of all companies, we established the terms frequency scale. For simplification purposes, we determined to select a reduced number of samples to three companies from the three sectors considered in this study.

### 4.1 Frequency of terms

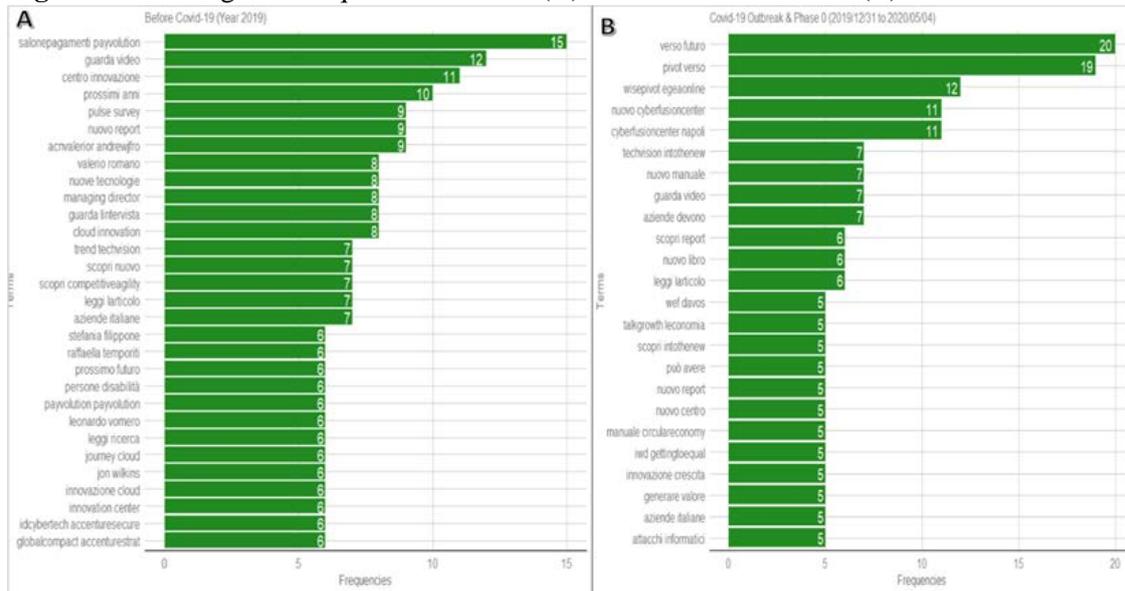
To accomplish the aim of this study, we chose the samples of nine companies based on their activity on Twitter (i.e., the amounts of tweets of both periods analysed). We found the selection corresponding to the relevance to the topic, and according to the frequency of terms, looking for the most mentioned words related to the pandemic crisis and innovation.

The depictions are based on the bigrams in the given period, based on the fact that they provide more information than single words.

#### 4.1.1 ICT companies

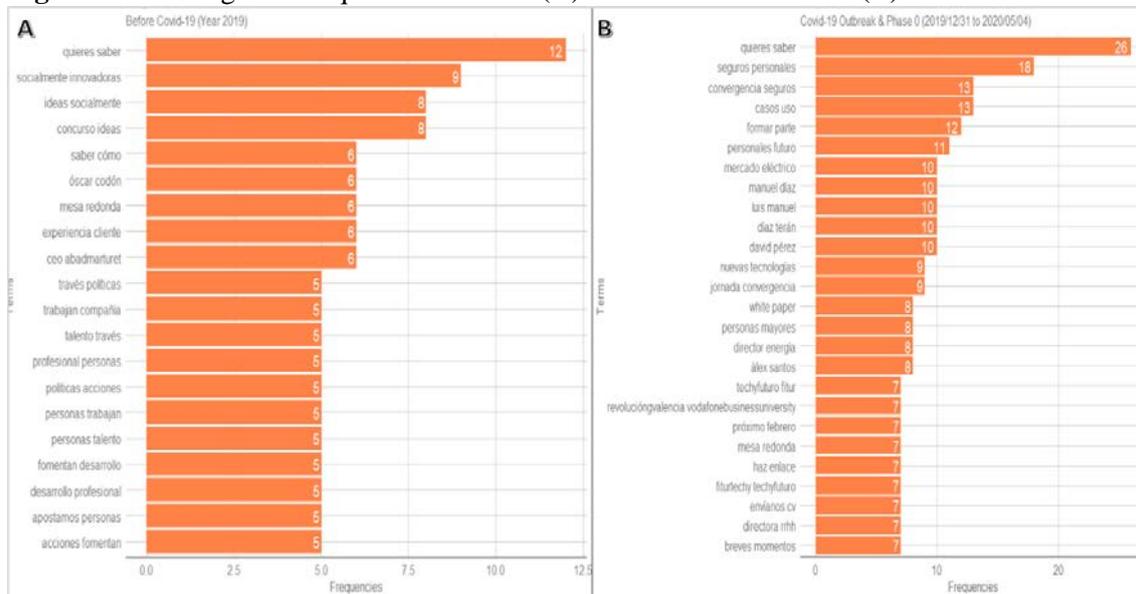
In the case of **ICT1** in **Figure 2 (A)**, it can be shown the most frequent bigrams of 2019, starting by a FinTech event: “Il salone dei pagamenti,” “video record,” and “innovation centre.” In **Figure 2 (B)**, is depicted the most frequent bigrams from the first months of 2020, is the release of the book “Pivot verso il futuro,” the new “Cyber Fusion Center Napoli,” and the “tech vision.”

**Figure 2.** ICT1 bigrams frequencies in 2019 (A) and since the outbreak (B)

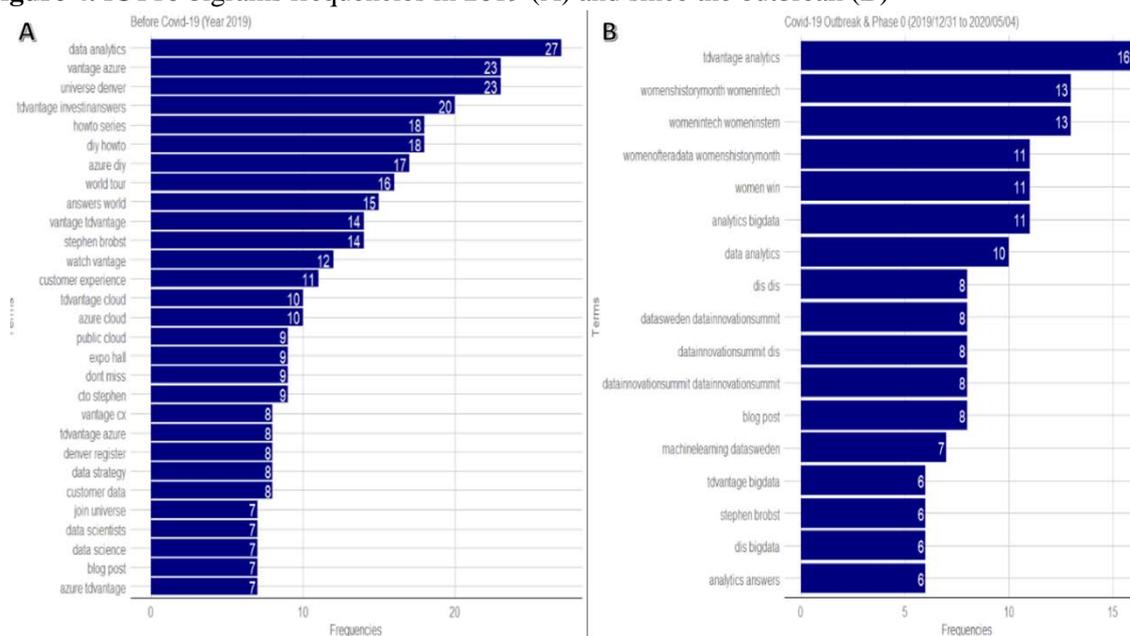


Regarding **ICT8**, in **Figure 3 (A)** it can be noticed the most frequent bigrams during 2019, as follows: “you want to know,” “socially innovative ideas,” and “ideas competition.” In **Figure 3 (B)**, for the period since the outbreak, again “you want to know,” is the most frequent bigram, followed by “personal insurance,” “use cases,” and “electric market.”

**Figure 3.** ICT8 bigrams frequencies in 2019 (A) and since the outbreak (B)



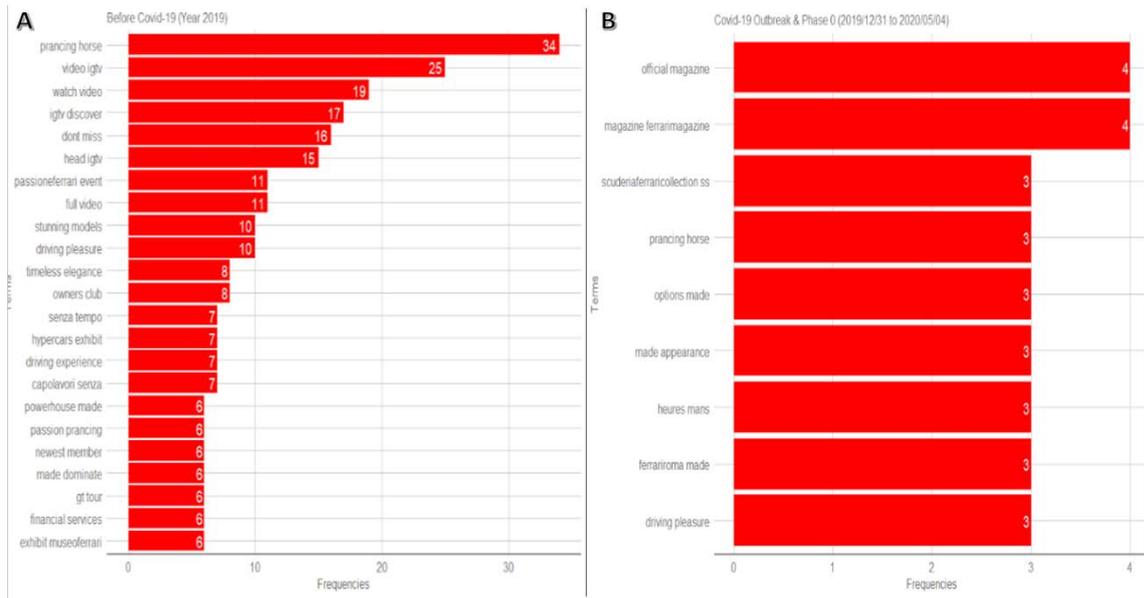
The third company analysed in the ICT sector, **ICT10**, as in **Figure 4 (A)**, can be seen, the most frequent terms are starting with “data analytics,” “vantage Azure,” and a conference located in Denver “Universe Teradata.” In regards to the period from outbreak and lockdown, in **Figure 4 (B)** is shown the most cited words such as their business intelligent solution “Vantage analytics,” a reference of “Women in tech,” and “analytics bigdata.”

**Figure 4.** ICT10 bigrams frequencies in 2019 (A) and since the outbreak (B)

#### 4.1.2 Automotive companies

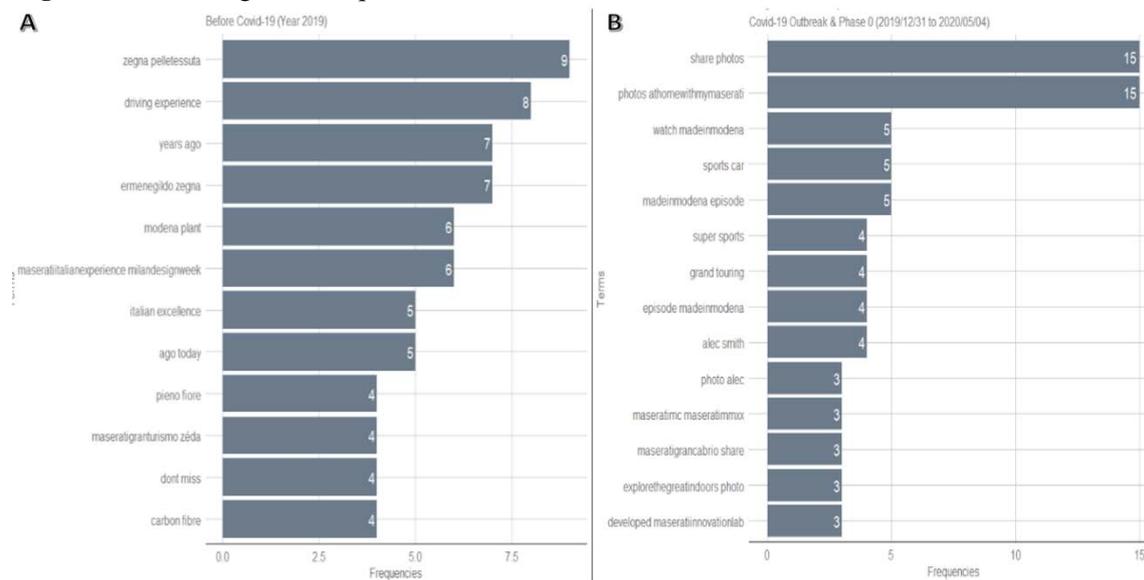
In the case of **AUT3** in **Figure 5 (A)**, it can be shown the most frequent bigrams during 2019, starting with a well-known allusion of the brand “prancing horse,” a reference of a “video IGTV” or Instagram TV, and an event called “passione Ferrari.” Regarding the period from the beginning of 2020 to the end of lockdown, in **Figure 5 (B)**, primarily referring to the official “Ferrari magazine,” the “scuderia Ferrari collection,” and again the reference “prancing horse.”

**Figure 5.** AUT3 bigrams frequencies in 2019 (A) and since the outbreak (B)



**Figure 6 (A)** shows the most frequent bigrams from **AUT8** Twitter account during the 2019 year, where it is mentioned in the first place “Zegna pelletessuta” referred to a brand Ermenegildo Zegna wallet. “Driving experience” is also mentioned, and the brand “Ermenegildo Zegna.” In the period that comprises the four first months of 2020, the automotive brand challenged customers to “share photos” with the hashtag “AtHomeWithMyMaserati,” and “made in Modena” as it can be seen in **Figure 6 (B)**.

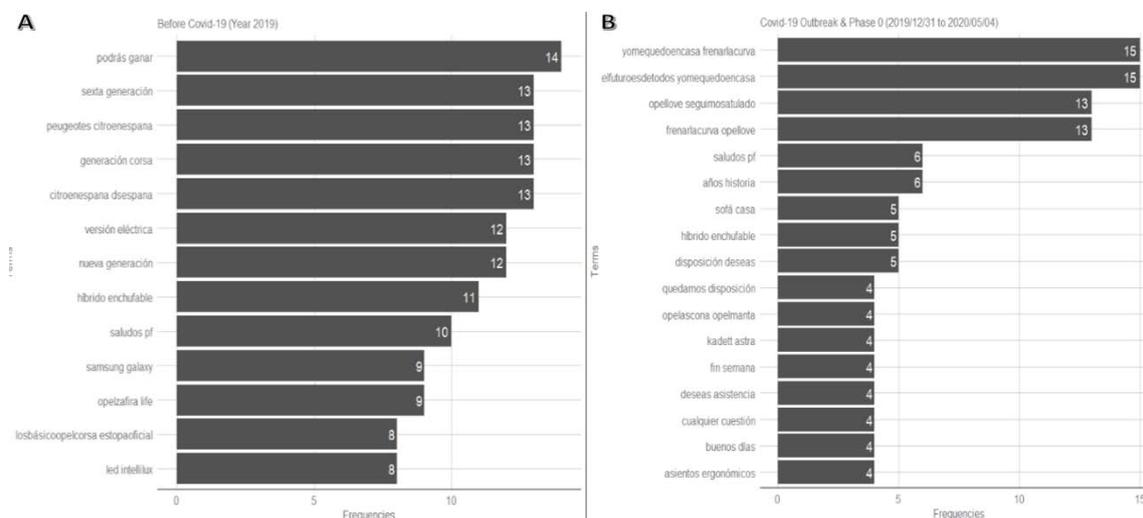
**Figure 6.** AUT8 bigrams frequencies in 2019 (A) and since the outbreak (B)



In the case of **AUT12** as can be seen in **Figure 7 (A)**, in the time before Covid-19 it has been remarked in the first place the bigrams “you can win,” followed by “sixth generation,” and “Peugeot Citroen Spain,” other car brands. Based on the period since the outbreak, in **Figure 7 (B)** can be seen the most cited bigrams such as “IstayinHome and curb the curve” referred to the

pandemic crisis. Also, in the same line, “the future is for everybody” and again a reference to stay at home. Lastly, “Opel love and we stay in your side” referred to the brand and its slogan.

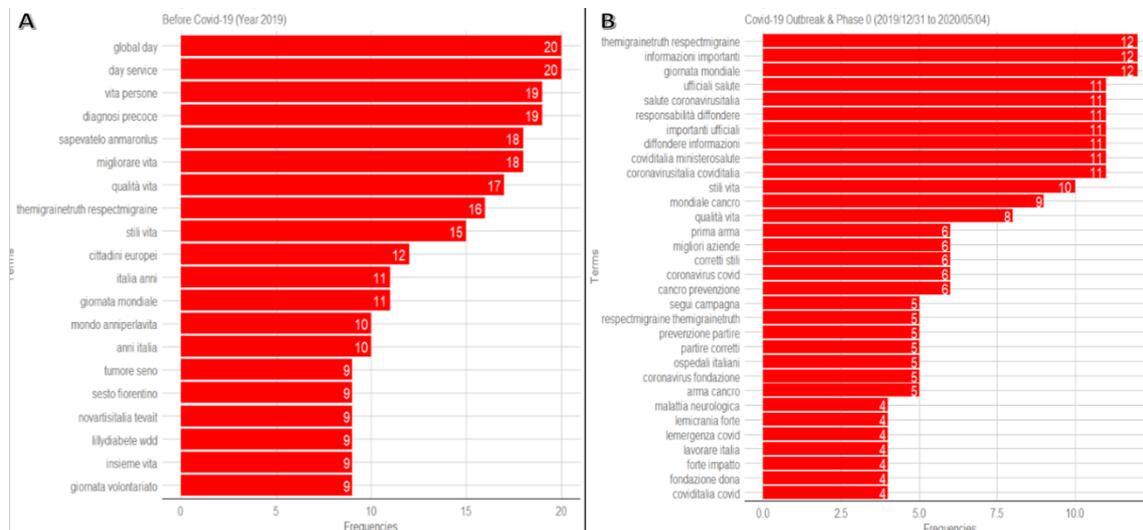
**Figure 7.** AUT12 bigrams frequencies in 2019 (A) and since the outbreak (B)



#### 4.1.3 Pharmaceutical companies

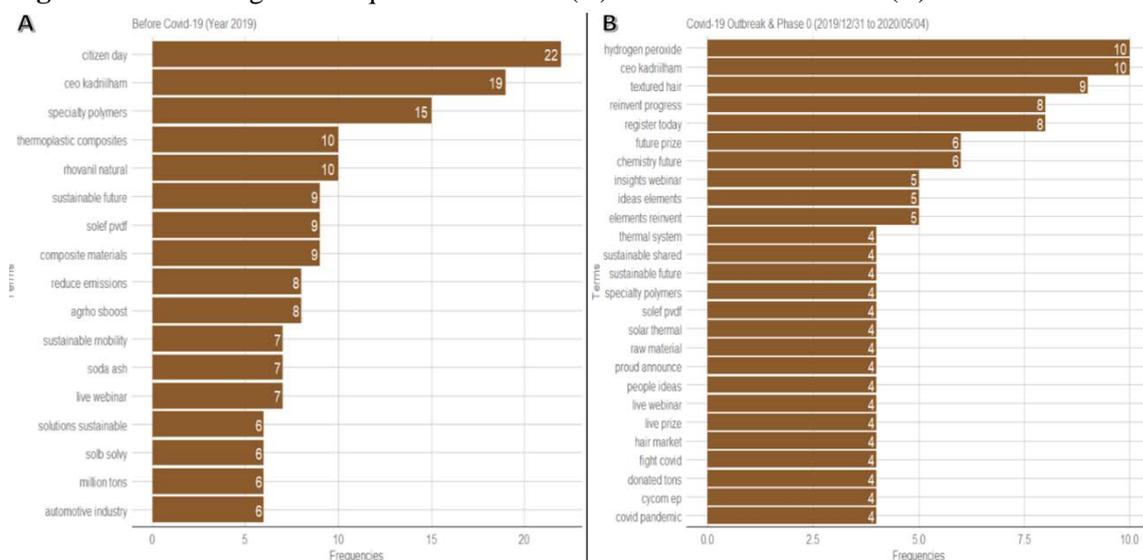
Concerning the field of pharmaceutical companies, starting with **PHA4** during 2019, the most frequent bigrams were: “global day and day of service” is referred to their employees’ volunteer day in local communities. Also, the “life of people” and “early diagnosis” appeared the most cited words, as can be seen in **Figure 8 (A)**. On the other side, **Figure 8 (B)** shows the period started from December 31, 2019, till May 4, 2020, the most frequent terms observed are: “the migraine truth and RespectMigraine,” followed in the same line with “important information” and “world day” as part of a migraine awareness campaign. It followed by “health and coronavirus Italia,” “COVID Italia,” and “spread information.”

**Figure 8.** PHA4 bigrams frequencies in 2019 (A) and since the outbreak (B)



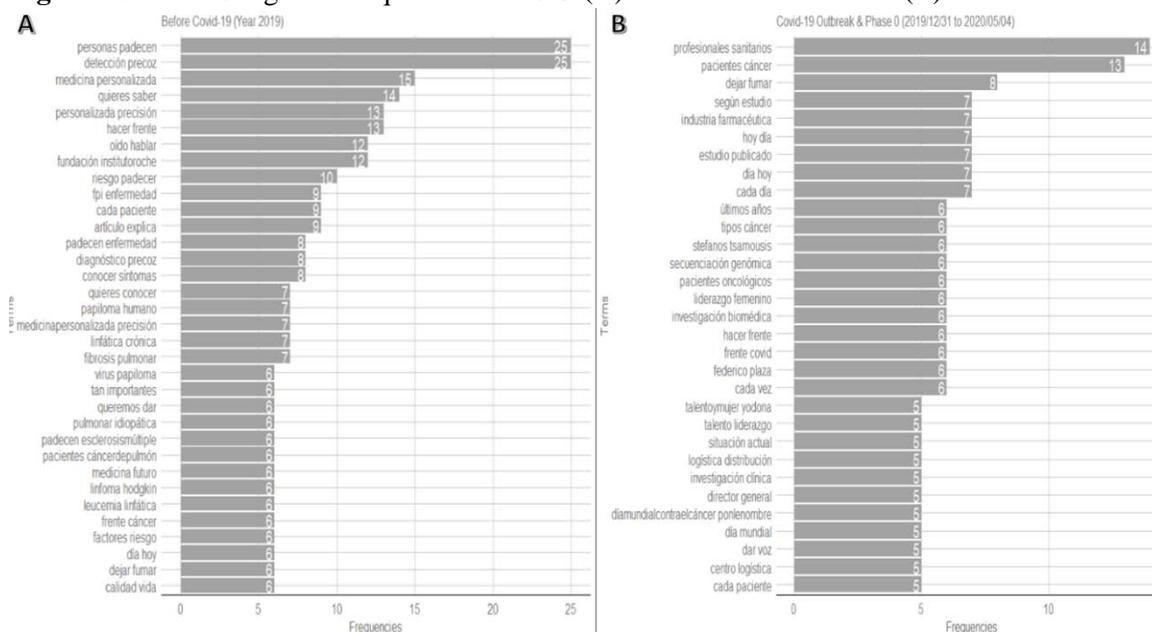
In **Figure 9 (A)**, referred to the tweets coming from **PHA10**, during 2019, the most frequent terms in its Twitter account are: “citizen day,” “CEO Kadri Ilham” the chairwoman, and “specialty polymers” which is provided by this company. In the case of **Figure 9 (B)**, about the period covered since the Covid-19 outbreak, it can be seen as the most cited bigram “hydrogen peroxide,” a chemical compound, and again “CEO Kadri Ilham.” Lastly, the third word: “textured hair” in reference to one of the company product.

**Figure 9.** PHA10 bigrams frequencies in 2019 (A) and since the outbreak (B)



Regarding **PHA18**, in 2019, as can be seen in **Figure 10 (A)**, the most cited words are counted in the same amount: the campaign “people suffer and early detection,” and also “personalised medicine” and “you want to know.” In **Figure 10 (B)**, during the pandemic crisis, the most frequent words were “health professionals,” and “cancer patients.” “Give up smoking” also appeared as a campaign promoted by this company.

**Figure 10.** PHA18 bigrams frequencies in 2019 (A) and since the outbreak (B)

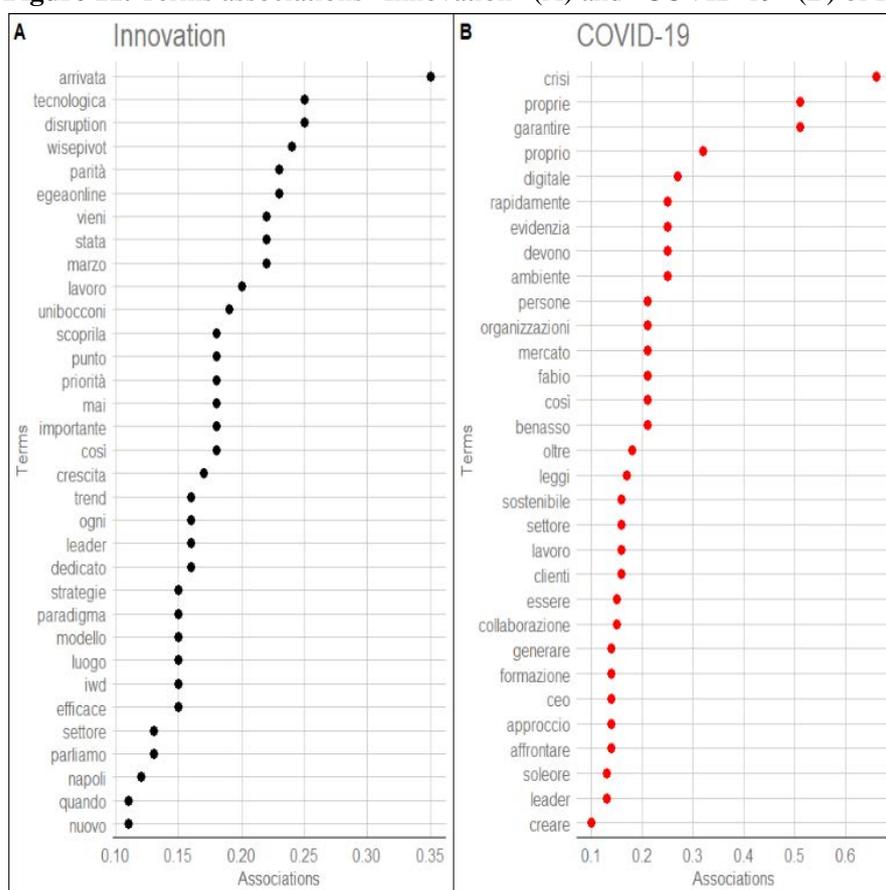


## 4.2 Terms correlation

Once we have analysed in depth the most relevant cases of companies that talked about “innovation” and “COVID-19,” we proceed to find the associations of these terms in both periods. To perform this analysis, we chose three companies with a significant incidence of both terms, in the period comprehend between December 31, 2019, and May 04, 2020, selecting one company per area. The following terms associations are linked to a ratio in order to show a scale on decimals and the list in a descending order that corresponds to each word.

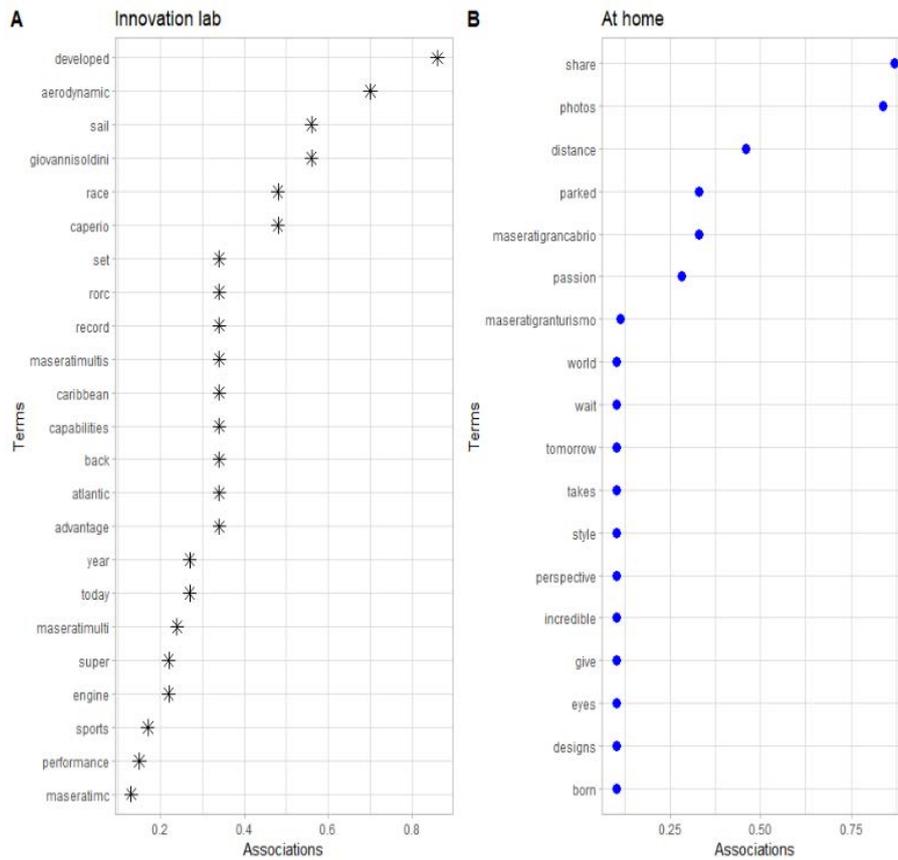
In the case of **ICT1**, **Figure 11** shows the terms associated in the side (A) “Innovation” is mostly related to “arrived,” “technology,” “disruption,” and “Wise Pivot” just to name the most connected words. In **Figure 11 (B)**, in reference to “COVID-19”, the associations are “crisis,” “own,” “guarantee,” an “digital.”

**Figure 11.** Terms associations “Innovation” (A) and “COVID-19” (B) of ICT1



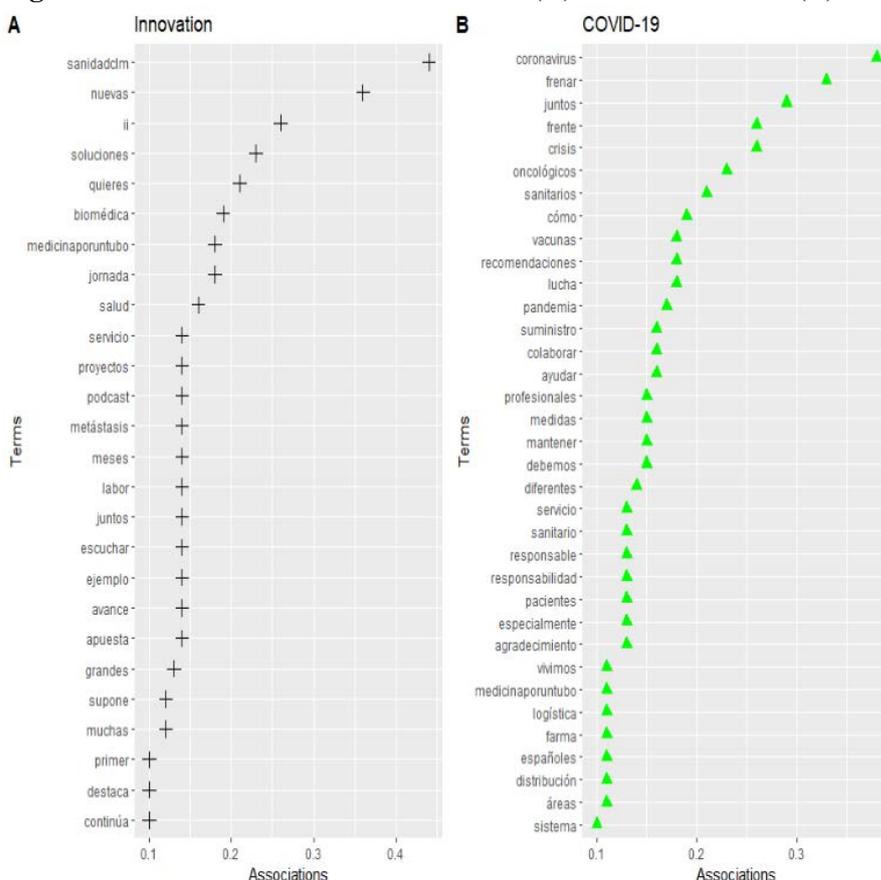
In **Figure 12**, about **AUT8**, it can be seen the associations of “Innovation Lab” (A) where the most linked words are (in descending order): “developed,” “aerodynamic,” “sail,” and “Giovanni Soldini” who is an Italian sailor. In the side (B) of **Figure 12**, related to the COVID-19 crisis is “At home” (or #IoRestoaCasa), and the most related word is “share” and “photos,” followed by “distance” and connected to the campaign “parked” and “Maserati gran cabrio.”

**Figure 13.** Terms associations “Innovation lab” (A) and “At home (COVID-19)” (B) of AUT8



**Figure 13** shows the terms connected to “innovation” (A) and “COVID-19” (B), as a close term that indicates the health crisis, in the depiction, concerning to **PHA18** Twitter account, during the period since the outbreak to the end to phase 0. In the first place, in the side A, starting with the most connected words such as “health clm,” where clm is referred to Castilla-La Mancha Spanish region, then “new” and “solutions”. Regarding **Figure 13 (B)**, and the COVID-19 reference, the most correlated words are “coronavirus,” liked to “curb,” “together” and “fore.”

**Figure 13.** Terms associations “Innovation” (A) and “COVID-19” (B) of PHA18

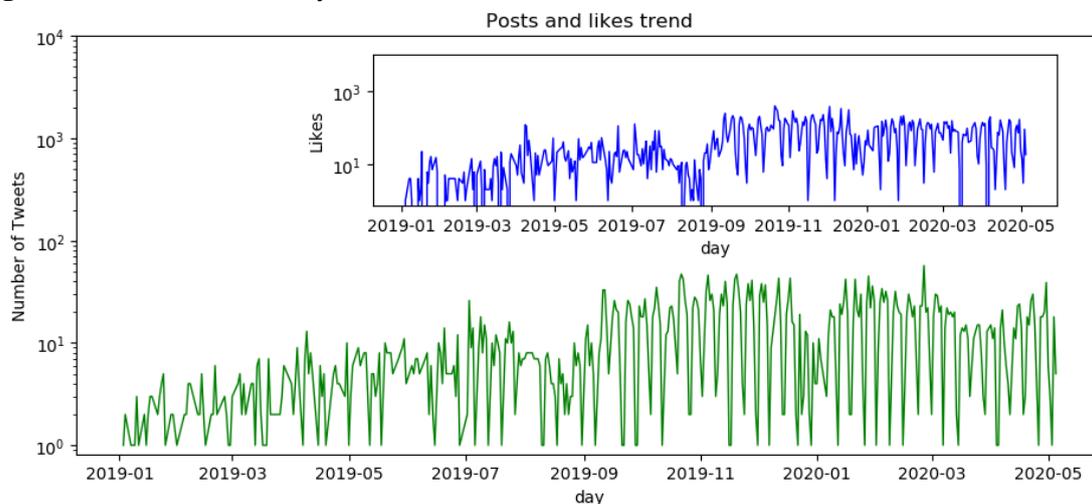


4.3 Trends by sectors

In the depictions below, we show the trend for the three analysed areas from January 1, 2019, to May 4, 2020, for the number of tweets and likes received, comprising the whole period where the tweets from the companies have been retrieved.

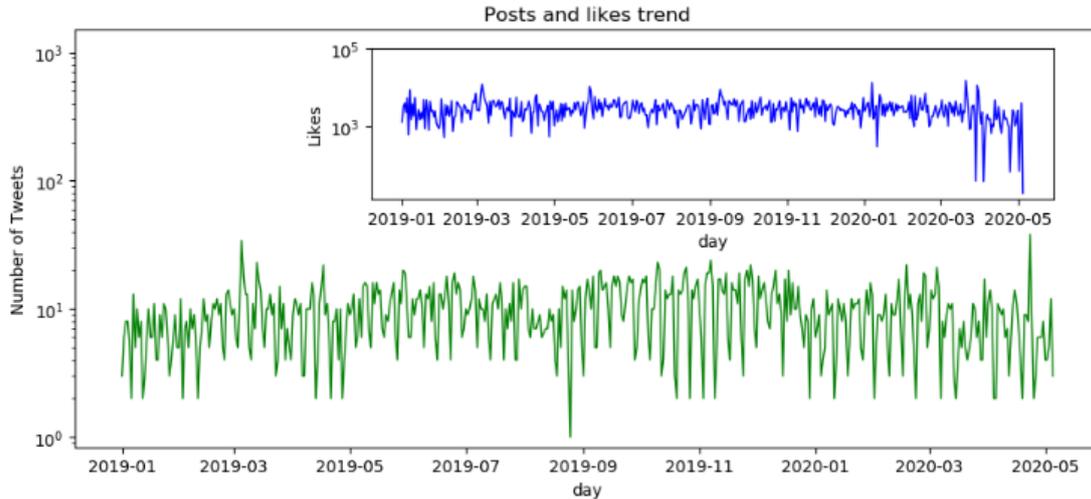
In **Figure 14**, it can be seen the behaviour of the ICT sector, where the number of tweets is increased since October 2019 (except a plummeting period in January 2020). Regarding "likes," its amount has risen consistently since October 2019 in the same line with the number of tweets.

**Figure 14.** ICT sector activity (Source: own elaboration)



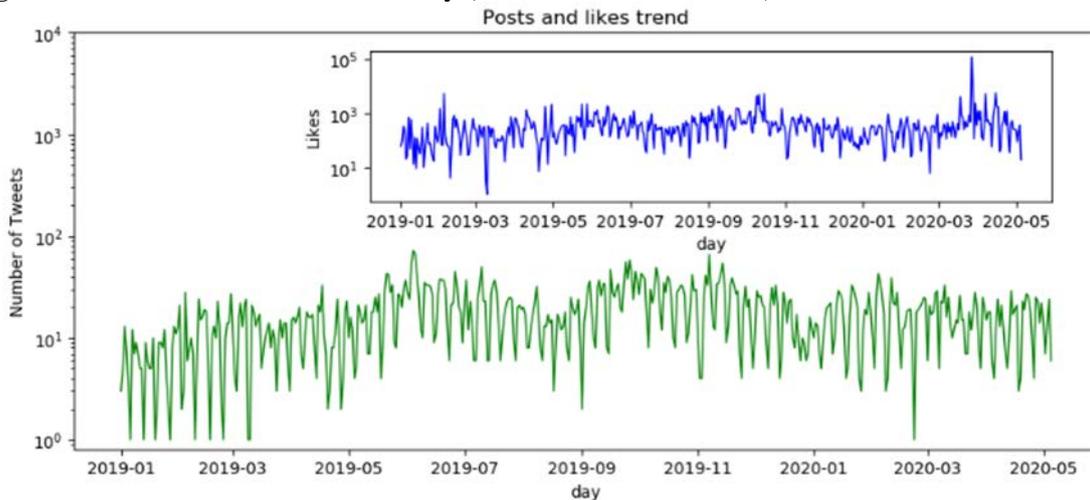
In regards to the Automotive sector, **Figure 15** illustrates that the number of tweets activity has been constant during the studied period. The same trend followed the number of likes for the whole period.

**Figure 15.** Automotive sector activity



According to the performance of the Pharmaceutical sector, **Figure 16** shows that it is possible to see how this sector companies have more activity by the number of posts. There are specific peaks and drops during the analysed period; however, the number of likes showed a constant behaviour activity, except for April 2020.

**Figure 16.** Pharmaceutical sector activity (Source: own elaboration)



#### 4.4 Activity comparison

If we observed the activity of the forty-five companies selected before during and the outbreak (see **Table 1**), and comparing it per each company, the number of tweets dramatically decayed in the latter period, except for **ICT3** and **ICT8**, where were both technological companies located in Spain increased, their activity in the opposite of the majority variation.

In **Table 2**, we have a summary of the activity during the COVID-19 crisis by sectors, and the period before (the year 2019), based on the mentions of company names, hashtags, pictures, and

websites references. **Table 2**, shows that Pharmaceutical company's mentions had been increased, as well as the references about websites. In the ICT sector, it has increased the mentions of websites. In the Automotive sector, during the lockdown, all activities decreased compared to the previous period.

**Table 2.** Activity comparison between analysed periods

| Sectors        | Company name | Hashtags | Pictures | Websites |
|----------------|--------------|----------|----------|----------|
| Pharmaceutical | +            | -        | -        | +        |
| ICT            | -            | -        | -        | +        |
| Automotive     | -            | -        | -        | -        |

## 5 DISCUSSION

The COVID-19 pandemic represents an unprecedented global health crisis that involved many organisations over the world that altered the development in the economy from the government level to individuals, with impacts in the industry, sports, and services, which also affected collective emotions, and social media (Bavel et al., 2020). The communication in companies and innovation performance is not exempt in such circumstances. However, as history taught us, all crisis create opportunities. According to Mention et al. (2020), “innovation in the COVID-19 times is happening at a rapid pace and in the most inspiring ways,” and this moment is a watershed in our way of living, and this rationale entails great challenges.

From this perspective, we analysed the performance in Twitter of forty-five organisations in three fields, and we selected them after obtained the analytical output having a database of tweets in two periods as a comparison based on their discourse of top terms mentions. After the first filter, nine companies showed their activity most feasible to implement our investigative approach.

We observed that taking the organisations individually, the number of tweets dramatically decreased during the COVID-19 period, except two companies from the ICT sector and the origin in Spain: **ICT3** and **ICT8**. This is probably due to the characteristics of their business, but the reasons are still not clear. Although, it seems that COVID-19 changed communication, altering the topics, like medical concerns and compromise with the lockdown enacted in most of the countries. Indeed, the appearance of terms related to COVID-19 is relevant in most of the companies if we treat them individually, especially noted in the frequency scale, where they are shown among the most cited words.

In general, we observed three different phases of communication during the pandemic period.

In the crisis's early stage, the companies have given mainly information to encourage calm and emphasising the prevention (e.g., “Wash your hands more often for 20 seconds with soap and water” or “use hand sanitiser”); how to stay safe is essential. The second phase has had a focus on adjusting to change and uncertainty. The third phase of the recovery and the desire to start again (many information were intending to help people make sense of the crisis and its impact).

It is worth to highlight the ICT field, represented in the case of **ICT1**, whose Twitter account was more related to the topic of innovation before and during the analysed periods, but not too much focus on the pandemic crisis. **ICT8** has a strong focus on innovation-related terms, with fewer mentions about COVID-19. Concerning **ICT10**, it is clear that they have been promoting their services with no mention of the health crisis; however, in this period they noticed another

type of innovation topics such as big data analytics and the awareness of women in tech, as an example. Due to the nature of their business in this field, it seems that the efforts are to show the connections with their clients primarily, and promoting their technology, rather than displaying any reference to the health crisis.

Regarding the Automotive field, **AUT3** mostly promoted some characteristics of its brand in both periods, with almost zero mentions of the health crisis. In the case of **AUT8**, its account often mentioned the experience with the brand, and in the second period, some allusions to the pandemic crisis. In regards to **AUT12**, they referenced their marketing campaign and associations with other automotive companies and some references to COVID-19 in the second period. Moreover, it is constant how the automotive brands promote their brands or their connection with partners; although, except for some companies, they neglect to refer to the COVID-19 situation because it was one of the segments that was most affected by this crisis.

Differently, the Pharmaceutical sector, that the pandemic crisis directly affected, as the case of **PHA4**, promoted events in its account, and in the four months of 2020 analysed, they firmly focused on COVID-19 crisis (and also, migraine), as can be deduced from the frequency scale. **PHA10** promoted the figure of its CEO and its chemistry products in both periods and a high mention of the health crisis. The appearance of terms such as sustainability and science is also remarkable in this company. The frequencies coming from **PHA18** Twitter account showed on campaigns such as cancer and smoking, and references as research and health professionals; however, the mentions regarding COVID-19 was much less than the other companies. The difference towards the pandemic crisis in the pharmaceutical companies might be due to the different lines of business, where they display their awareness in different ways.

The terms' association demonstrated remarkable outcomes, after selecting three samples during the period between December 31, 2019, and May 4, 2020, where a comparison of "innovation" and "COVID-19" has been done to explore the correlation with a ratio of 10% (0.1 in decimal notation) as a minimum. Following the role of dissemination, Twitter endeavours, rapid and novel information dissemination (Rosenberg et al., 2020), and hashtags take part in identifiable data. It is interesting to follow the balance between innovation and "technology," "disruption," but also "solutions," "health" and "developed." For the case of COVID-19, we found the expected correlation with the campaigns such as "in-home," "curb the curve," "together," and "crisis."

This study is an exploratory step to find more information regarding the strategy of the companies investigated is related to the changes in the communication contents pre and post COVID-19, and the relative importance of innovation. We assumed that social media is a powerful tool to express the evolution of the strategy in which the company is immersed (or in this case, the sector), and the references to radical changes, in some cases, are a fact. During the pandemic situation, the companies image has a vital function, leading to promote themselves (or increasing their activity), and above all, with regard to pharmaceutical companies.

Limitations had been critical to perform our analysis, in the case of the crawler, that due to the restrictions in the API, the collection of tweets during 2019 was dissimilar (i.e., in some accounts, it was retrieved throughout the year, others, only some months). Besides, from the total amount of companies – the forty-five analysed in the beginning –, and we realised that many companies do not explore the capacities of social media as a tool of communication, which is the role of Twitter.

Forthcoming studies might focus on other dimensions such as social network analysis (SNA), and artificial intelligence (AI) analysis, that although present challenges to help to track and predict future health crises (Jahanbin & Rahmanian, 2020; Naudé, 2020) Another dimension to explore, tracing vast quantities of data, is to provide us with some hints to discover hidden patterns to anticipate strategies to face upcoming events as COVID-19 represents. To sum up, it is expected to contribute to new approaches to the changing scenarios with robust analysis to understand the role of companies and the responsibility of innovative actions as a critical element in the future.

## Acknowledgements

We would like to thank for the support of the European Forum for Studies of Policies for Research and Innovation (Eu-SPRI Forum) through the grant of EU-SPRI Circulation Award. Furthermore the authors would like to thank for their helpful comments and suggestions Serena Fabrizio and Alessia Fava.

## 6 REFERENCES

- Bavel, J. J. V., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., & Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*, 4(5), 460–471. <https://doi.org/10.1038/s41562-020-0884-z>
- Brandtzaeg, P. B., & Følstad, A. (2016). Social Media Use and Innovations: Introduction to the Special Issue. *The Journal of Media Innovations*, 3(1), 1–3. <https://doi.org/10.5617/jmi.v3i1.2862>
- Chen, E., Lerman, K., & Ferrara, E. (2020). Tracking Social Media Discourse About the COVID-19 Pandemic: Development of a Public Coronavirus Twitter Data Set. *JMIR Public Health and Surveillance*. <https://doi.org/10.2196/19273>
- Chen, H., Chiang, R. H. L., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS Quarterly: Management Information Systems*, 36(4), 1165–1188. <https://doi.org/10.2307/41703503>
- Chesbrough, H. (2020). To recover faster from Covid-19, open up: Managerial implications from an open innovation perspective. *Industrial Marketing Management*. <https://doi.org/10.1016/j.indmarman.2020.04.010>
- Dobele, A., Steel, M., & Cooper, T. (2015). Sailing the seven C's of blog marketing: understanding social media and business impact. *Marketing Intelligence and Planning*, 33(7), 1087–1102. <https://doi.org/10.1108/MIP-02-2015-0039>
- He, W., & Wang, F. K. (2016). A process-based framework of using social media to support innovation process. *Information Technology and Management*, 17(3), 263–277. <https://doi.org/10.1007/s10799-015-0236-2>
- Hitchen, E. L., Nylund, P. A., Ferràs, X., & Mussons, S. (2017). Social media: open innovation in SMEs finds new support. *Journal of Business Strategy*, 38(3), 21–29. <https://doi.org/10.1108/JBS-02-2016-0015>
- Hoffman, D. L., & Novak, T. P. (1996). Marketing in Hypermedia Computer-Mediated Environments: Conceptual Foundations. *Journal of Marketing*, 60, 50–68. Retrieved from <http://www.switch.ch/switch/Internet-Books.txt>
- Hsia-Ching, C. (2010). A new perspective on Twitter hashtag use: diffusion of innovation theory. *Proceedings of the 73rd ASIS & T Annual Meeting on Navigating Streams in an Information Ecosystem*, 1–4. Retrieved from <https://dl.acm.org/doi/10.5555/1920331.1920454>
- Investis. (2015). Social Media for Corporate Communications: A Review of Corporate Social Media Use in the US and in the UK. Retrieved July 14, 2020, from <https://irsociety.org.uk/resources/white-papers/item/social-media-for-corporate-communications-investis>
- Jahanbin, K., & Rahmanian, V. (2020). Using twitter and web news mining to predict COVID-19 outbreak. *Asian Pacific Journal of Tropical Medicine*, (13). <https://doi.org/10.4103/1995-7645.279651>
- Jurafsky, D., & Martin, J. H. (2008). *Speech and Language Processing. An introduction to natural language processing, computational linguistics, and speech recognition* (Second; P. Norvig & S. Russell, Eds.). Retrieved from <http://www.cs.colorado.edu/~martin/slp2.html>
- Linnenluecke, M. K. (2017). Business and Management Research: A Review of Influential Publications and a Research Agenda Article in. *International Journal of Management Reviews*, 19. <https://doi.org/10.1111/ijmr.12076>
- Liu, B., Hu, M., & Cheng, J. (2005). Opinion observer: analyzing and comparing opinions on the Web. *Proceedings of the 14th International Conference on World Wide Web - WWW '05*,

342. <https://doi.org/10.1145/1060745.1060797>
- Martin-Rios, C. (2020). Unlocking Sustainable Strategic Renewal After COVID-19: Opportunities for Hospitality. Retrieved June 9, 2020, from Hospitality Net website: <https://www.hospitalitynet.org/opinion/4098309.html>
- McNutt, M. (2020, May 15). Lessons from the crucible of crisis. *Science*, Vol. 368, pp. 683–683. <https://doi.org/10.1126/science.abc6866>
- Mehmet, M. I., & Clarke, R. J. (2016). B2B social media semantics: Analysing multimodal online meanings in marketing conversations. *Industrial Marketing Management*, 54, 92–106. <https://doi.org/10.1016/j.indmarman.2015.12.006>
- Mention, A.-L., Pinto Ferreira, J. J., & Torkkeli, M. (2020). Coronavirus: a catalyst for change and innovation. *Journal of Innovation Management*, 8(1). [https://doi.org/10.24840/2183-0606\\_008.001\\_0001](https://doi.org/10.24840/2183-0606_008.001_0001)
- Mount, M., & Martinez, M. G. (2014). Social Media: A Tool for Open Innovation. *California Management Review*, 56(4), 124–143. <https://doi.org/10.1525/cmr.2014.56.4.124>
- Naudé, W. (2020). Artificial intelligence vs COVID-19: limitations, constraints and pitfalls. *AI & SOCIETY*, 1, 3. <https://doi.org/10.1007/s00146-020-00978-0>
- Nulty, P., Theocharis, Y., Popa, S. A., Parnet, O., & Benoit, K. (2016). Social media and political communication in the 2014 elections to the European Parliament. *Electoral Studies*, 44, 429–444. <https://doi.org/10.1016/J.ELECTSTUD.2016.04.014>
- OECD. (2011). OECD Science, Technology and Industry Scoreboard 2011. In *OECD Publishing*. [https://doi.org/10.1787/sti\\_scoreboard-2011-en](https://doi.org/10.1787/sti_scoreboard-2011-en)
- Orange, E. (2011). Augmented, Anonymous, Accountable: The Emerging Digital Lifestyle. *The Futurist*, 45(4), 37–41. Retrieved from <https://search.proquest.com/docview/874499041?pq-origsite=gscholar&fromopenview=true>
- Pérez-González, D., Trigueros-Preciado, S., & Popa, S. (2017). Social Media Technologies' Use for the Competitive Information and Knowledge Sharing, and Its Effects on Industrial SMEs' Innovation. *Information Systems Management*, 34(3), 291–301. <https://doi.org/10.1080/10580530.2017.1330007>
- Rajan, D., Koch, K., Rohrer, K., Bajnoczki, C., Socha, A., Voss, M., ... Koonin, J. (2020). Governance of the Covid-19 response: a call for more inclusive and transparent decision-making. *BMJ Global Health*, 5(5), e002655. <https://doi.org/10.1136/bmjgh-2020-002655>
- Rosenberg, H., Syed, S., & Rezaie, S. (2020). The Twitter pandemic: The critical role of Twitter in the dissemination of medical information and misinformation during the COVID-19 pandemic. *Canadian Journal of Emergency Medicine*. <https://doi.org/10.1017/cem.2020.361>
- Simula, H., Töllinen, A., & Karjaluo, H. (2013). Crowdsourcing in the social media era: A case study of industrial marketers. *Journal of Marketing Development and Competitiveness*, 7(2), 122–137. Retrieved from <https://jyx.jyu.fi/handle/123456789/42415>
- Stern, B. (1994). A revised communication model for advertising: Multiple dimensions of the source, the message, and the recipient. *Journal of Advertising*, 23(2), 5–15. <https://doi.org/10.1080/00913367.1994.10673438>
- Tietze, F., Vimalnath, P., Aristodemou, L., & Molloy, J. (2020). *Crisis-Critical Intellectual Property: Findings from the COVID-19 Pandemic*. <https://doi.org/10.17863/CAM.51142>
- Tognini Bonelli, E. (2010). Theoretical overview of the evolution of corpus linguistics. In A. O'Keefe & M. McCarthy (Eds.), *The Routledge Handbook of Corpus Linguistics* (pp. 14–27). <https://doi.org/10.4324/9780203856949>
- Tsimonis, G., & Dimitriadis, S. (2014). Brand strategies in social media. *Marketing Intelligence and Planning*, 32(3), 328–344. <https://doi.org/10.1108/MIP-04-2013-0056>
- Twitter. (2013). About Twitter. Retrieved June 28, 2020, from [https://about.twitter.com/en\\_us/company.html](https://about.twitter.com/en_us/company.html)
- Vanhaverbeke, W., Roijakkers, N., Lorenz, A., & Chesbrough, H. (2017). The importance of connecting open innovation to strategy. In *Strategy and Communication for Innovation: Integrative Perspectives on Innovation in the Digital Economy* (pp. 3–15).

[https://doi.org/10.1007/978-3-319-49542-2\\_1](https://doi.org/10.1007/978-3-319-49542-2_1)

Xiao, R. (2010). Corpus Creation. In N. Indurkha & F. Damerau (Eds.), *The handbook of Natural Language Processing* (2nd., pp. 147–165). Retrieved from [http://www.lancaster.ac.uk/fass/projects/corpus/ZJU/xpapers/Xiao\\_corpus\\_creation.pdf](http://www.lancaster.ac.uk/fass/projects/corpus/ZJU/xpapers/Xiao_corpus_creation.pdf)

Xifra, J. (2020). Comunicación corporativa, relaciones públicas y gestión del riesgo reputacional en tiempos del Covid-19. *El Profesional de La Información*, 29(2). <https://doi.org/10.3145/epi.2020.mar.20>

## CNR-IRCrES Working Papers

2020

- N. 7/2020 [The proposal of a new hybrid methodology for the impact assessment of energy efficiency interventions. An exploratory study](#). Monica Cariola, Greta Falavigna.
- N. 6/2020 [The technology innovative system of the Silicon Valley](#). Angelo Bonomi.
- N. 5/2020 [Storia dell'industria delle macchine utensili in Piemonte dalle origini alla seconda guerra mondiale](#). Secondo Rolfo.
- N. 4/2020 [Blockchain e Internet of Things per la logistica Un caso di collaborazione tra ricerca e impresa](#). Edoardo Lorenzetti, Lucio Morettini, Franco Mazzenga, Alessandro Vizzarri, Romeo Giuliano, Paolo Peruzzi, Cristiano Di Giovanni.
- N. 3/2020 [L'impatto economico e fiscale di un evento culturale: misure e scala territoriale](#). Giovanna Segre, Andrea Morelli.
- N. 2/2020 [Mapping the tangible and intangible elements of the historical buildings and spaces](#). Edoardo Lorenzetti, Nicola Maiellaro.
- N. 1/2020 [Il lavoro agile negli enti pubblici di ricerca](#). Emanuela Reale, Serena Fabrizio, Andrea Orazio Spinello.

2019

- N. 6/2019 [Women's candidatures in local elections: does the context matter? Empirical evidence from Italian municipalities](#). Igor Benati, Greta Falavigna, Lisa Sella.
- N. 5/2019 [Research activities in Nanotechnologies and Nanosciences: an analysis of Piedmont's nanotech research system](#). Ugo Finardi.
- N. 4/2019 [Xylella fastidiosa: patogenesi, danni economici e lotta al disseccamento rapido dell'olivo](#). Maurizio Conti.
- N. 3/2019 [Flussi di traffico attraverso il tunnel automobilistico del Frejus: un semplice esercizio di forecasting e alcune considerazioni a margine](#). Ugo Finardi.
- N. 2/2019 [The Start-up Venture Capital Innovation System Comparison with industrially financed R&D projects system](#). Angelo Bonomi.
- N. 1/2019 [Complessità delle organizzazioni, complessità della formazione. Report di studio qualitativo ed analisi ermeneutica del Modello TRASE – IRCRES/CNR-IMO](#). Anna Chiara Scardicchio.

2018

- N. 13/2018 [Competenze di sviluppo sistemico evolutivo per la leadership e le organizzazioni orizzontali](#). Erica Rizziato, Erika Nemmo.
- N. 12/2018 [Organizzazioni e leadership orizzontali: il percorso di training sistemico evolutivo \(TRASE\)](#). Erica Rizziato.
- N. 11/2018 [Point-in-time vs.through-the-cycle: filosofie di rating a confronto](#). Franco Varetto.
- N. 10/2018 [Evaluating social innovation: results and emerging issues from a random-trial evaluation of a program for the inclusion of migrant adolescents](#). Valentina Lamonica, Elena Ragazzi, Lisa Sella.
- N. 9/2018 [Promozione dell'Imprenditorialità nelle Nuove Tecnologie. Caso Studio: Associazione "La Storia nel Futuro"](#). Angelo Bonomi.
- N. 8/2018 [Nanotechnology patenting in Piedmont: analysis and links with research and industrial environment in the Region](#). Ugo Finardi.
- N. 7/2018 [I canali innovativi di industria 4.0 e le PMI](#). Angelo Bonomi.
- N. 6/2018 [Does the construction of biogas plants affect local property values?](#). Marco Modica.
- N. 5/2018 [Public research in Nanotechnology in Piedmont \(Italy\)](#). Ugo Finardi.
- N. 4/2018 [Le tecnologie di Industria 4.0 e le PMI](#). Angelo Bonomi.
- N. 3/2018 [Overcoming sustainability barriers through Formalized Network Contracts \(FNCs\): the experience of Italian SMEs](#). Laura Corazza, Maurizio Cisi, Greta Falavigna.

[Numeri precedenti/Previous issues.](#)

## ABSTRACT

We address the diffusion of information about the innovation before and during COVID-19 emergency with extensive data analysis on Twitter. We examine Italian and Spanish companies engaged in ICT, automotive, and pharmaceutical fields to understand how the message on innovation has changed. Furthermore, we observe the evolution of the discourse on a global scale, also considering the feedback of their users' retweets, likes, etc. We used web scraping approaches to retrieve the information on the platform, and we analysed the data through text mining, and complex system approaches. Making the period between the year 2019 – previously the outbreak – and during COVID-19 pandemic as balanced as possible, we extrapolated the data from December 31, 2019, to May 4, 2020. In this work, we provide an in-depth analysis of the dynamics of communication in a time window in which narratives and moods in social media due to COVID-19 have emerged and spread. In this work, we also performed a comparative analysis of messages (in three different languages: Italian, Spanish, and English) elaborated by companies localised in Spain and Italy.