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Social Transmission of Online Content about Environmental and Technological Risk: A Study of the Factors Determining the Online Transmission of Risk Information

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López-Asensio, S.; Oltra C.; Sala, R.; Germán, S.
23 pp. 15 refs. 9 figs. 5 tables

Abstract:

Why certain pieces of online content about environmental and technological risks are more viral than others? This report analyses the mechanisms underlying social transmission of media content about risks through Internet social networks. The study is based on a quantitative content analysis of a sample of newspaper articles on risk issues. We specifically examine the impact of content characteristics (emotionality) and the characteristics of the risk (type, impact and scope) in the social transmission. The results first show that the majority of articles about risk issues are not shared by readers, while a few of them have a very high social transmission. Second, that the emotions generated by the content are significantly associated with the transmission of the articles. Third, that the characteristics of the risk also have a moderate influence on the transmission of the content, but this effect appears to be statistically non-significant for most of the studied variables. Results are discussed with existing studies on the social amplification of risk as well as on content virality and interpersonal communication.

Transmisión Social de Contenidos sobre el Riesgo Ambiental y Tecnológico: Un Estudio de los Factores Determinantes de la Transmisión Online de Información sobre el Riesgo

López-Asensio, S.; Oltra C.; Sala, R.; Germán, S.
23 pp. 15 refs. 9 figs. 5 tablas

Resumen:

¿Por qué ciertos contenidos en línea sobre riesgos ambientales y tecnológicos son más virales que otros? Este informe analiza los mecanismos que subyacen a la transmisión social del contenido de los medios sobre los riesgos a través de las redes sociales de Internet. El estudio se basa en un análisis de contenido cuantitativo de una muestra de artículos periodísticos sobre riesgos. Examinamos específicamente el impacto las características del contenido (emocionalidad) de la información sobre el riesgo y las características del riesgo (tipo, impacto y alcance) en la transmisión social. Los resultados muestran, en primer lugar, que la mayoría de los artículos sobre temas de riesgo no son compartidos por los lectores, mientras que algunos de ellos tienen una transmisión social muy alta. Segundo, que las emociones generadas por el contenido están significativamente asociadas con la transmisión de los artículos. Tercero, que las características del riesgo también tienen una influencia moderada en la transmisión del contenido, pero este efecto parece ser estadísticamente no significativo para la mayoría de las variables estudiadas. Los resultados se discuten con estudios existentes sobre la amplificación social del riesgo, así como sobre la viralidad del contenido y la comunicación interpersonal.

Social transmission of online content about environmental and technological risk: A study of the factors determining the online transmission of risk information

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December 2017

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CIEMAT's Sociotechnical Research Center conducts social research on environmental risk perception, social reactions to energy technologies, environmental behaviour and safety culture.

TABLE OF CONTENTS

1. Introduction

The social transmission of information about environmental and technological issues has changed significantly in the last years due to the emergence of the Internet and the social media. The existence of new channels, the broader range and the speed of transmission has opened a new situation, where people can find, read and share information with an incalculable number of people and faster than ever before. How does this new setting influence the social transmission of information about environmental and technological risks?

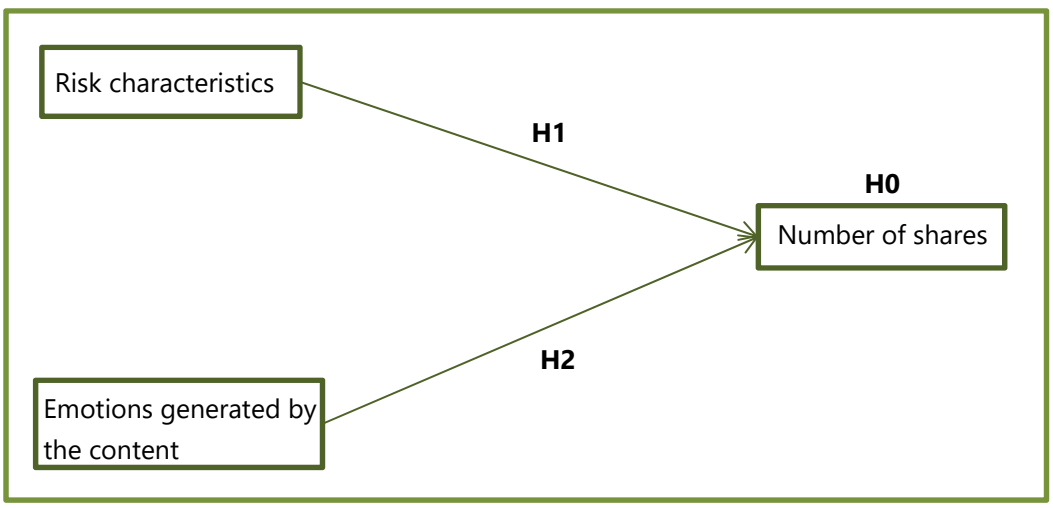
This report includes the analysis carried out to investigate the social transmission, through Internet social networks, of media content about environmental, technological and biological risks. The objective of the study, based on a content analysis of newspaper articles on risk issues, has been to examine the mechanisms that cause certain contents to be more or less shared by individuals in social networks. We follow partially the work by Berger & Milkman (2012). We specifically analyse the **impact of the emotional content of the information** about the risk and the **characteristics of the risk** (type, impact and scope) in the social transmission.

Thus, the present study aims to contribute to previous research in risk perception by trying to answer the following research question:

> *To what extent do **the content of the information** (emotionality) and the **characteristics of the risk** (type, impact and scope) determine the degree of social transmission of information?*

In this study, the social transmission of information is understood as the number of times a news article is shared on social networks. Our hypothesis is that both the characteristics of the risk and the emotions generated by the content have an impact on the number of times a story is shared (Figure 1).

Figure 1. Hypothesis



The specific objectives of the study are the following:

- Describe to what extent newspaper articles about risk (**environmental, technological and biological**) are shared.
- Examine the impact in the transmission of factors related to risk characteristics (**type, impact and scope**).
- Examine the impact in the transmission of different factors related to the content (**emotionality**).

2. Literature review

Individuals disseminate and share opinions and information with other individuals on many issues, from aspects of personal life to issues related to health, leisure or work. This information can have effects on the beliefs, attitudes and behaviours of individuals. In general, it is considered that this informal transmission of information has important consequences on what individuals think and do in their daily lives (Berger, 2014; Bristor, 1990). Through multiple interactions, informally transmitted information can potentially reach and influence many receptors (Lau & Ng, 2001). Thus, the informal transmission of information can first raise awareness of an issue; second, to have a persuasive effect, in the sense of generating changes in the beliefs, attitudes and intentions of the behaviour of individuals.

In the area of risk perception research, the role of informal social transmission on environmental, technological or biological risk content has received limited attention. With the exception of studies framed in the perspective of social risk amplification (Kasperson et al., 1988), research on risk perception has generally been focused on the cognitive processes by which individuals generate judgments about the risk, as well as in the social and cultural contexts in which they occur. In some ways, risk perception research has been characterized by considering individuals as disconnected units from their social networks and the social system as a whole (Scherer & Cho, 2003), as well as by paying more attention to related elements with the type of risk, the context of the risk, the personality of the individuals or their mental models, and less attention to the informal processes of information exchange on the risk (Wachinger, Renn, Begg, & Kuhlicke, 2013).

With the massive growth of the Internet and a totally unknown future, authors like Morris & Ogan (1996) claimed that was a mistake to ignore the Internet as a mass communication tool. At that time, many researchers underestimated the power that could have to interconnect people through the network, probably because of the unknown future and uncertainty of this technology. This gives us the notion of the rapid spread of new technologies that can change the way that individuals communicate and, therefore, also the way in which the news become viralized.

Berger & Milkman (2012) have studied the mechanisms to understand what makes online content viral. The authors examined how emotions generated by content condition their virality. Their results show that positive content is more viral than negative content, but this relationship between the emotion and social transmission is influenced by other variables, such as the physiological arousal. In their findings, the content that evokes high-arousal positive or negative emotions is more viral than the low-arousal content.

Guerini and Staiano (2015), in a study of a high-coverage and bilingual corpus of documents also found a substantial viral effect of evoked emotions. The authors show that the relation between affect and virality is more complex than expected. Viral facets seem to be coherently affected by particular configurations of dominance and arousal of the evoked emotions.

Studies such as the one by Hansen, Arvidsson, Nielsen, Colleoni, & Etter (2011) have explored the virality of content on a social network like Twitter. From the number of retweets, the authors analyse which contents are more viral, considering that is a social network where both news and other types of messages are shared. They conclude affirming that the messages that contain news if these are more negative the publication is shared to a greater extent. On the other hand, in non-news messages, the negative messages are shared less.

Before the emergence of social networks and the generalization of the connected world, Heath (1996) studied the role of emotionality on informal transmission of news by analysing the valence, that is, whether the news is positive or negative. And on the other hand, how much "extreme" is the news, so the "level" of positivity or negativity that it has. In its case, they observed in two studies that people were more willing to pass along bad news than equally believable good news, contradicting the general tendencies to want to see the world as a stable and controllable place. However, in a third study, they observed that people do not display a simple preference for bad news, instead of passing along information that matches the emotional valence of the conversation topic.

3. Method

To examine the social transmission of risk news we undertook a content analysis of newspaper articles covering news related to environmental, technological and biological risks.

3.1. Newspaper articles

The articles were collected from the digital versions of two Spanish newspapers: "El Mundo" (Newspaper 1) and "ABC" (Newspaper 2). These newspapers were selected because they are the only two Spanish general information newspapers that allow registering the total number of times a news article has been shared on different social networks (AIMC, 2016). A total of 200 news articles published in 2016 and 2017 were selected, covering the four types of studied risks (Table 1).

Table 1. Sample of newspaper articles

	El Mundo (Newspaper 1)	**ABC** (Newspaper 2)
Environmental-anthropogenic	30	25
Environmental-natural	22	25
Technological	18	25
Biological	30	25
Total	**100**	**100**
	200	

The newspaper articles were identified via search engines in the two newspapers using various keywords (see Table 2). In addition to the keywords, all news had to include also the word "risk". We focused our selection of articles on four types of physical risks that can potentially affect the health and well-being of people and ecosystems. First, the environmental-anthropogenic risks, those environmental risks caused by the intervention of humans; secondly, the environmental-natural, environmental risks that have not been caused by human action; third, the technological risks, which are caused by the intervention of technologies; and finally the biological ones: organisms that pose a threat to human health. Within these larger types of risks, we selected a number of specific risks.

Table 2. Search protocol

Type of risk	Specific risk	Keywords
Environmental-anthropogenic	a. Environmental risk	"Environmental risk"
	b. Climate change	"Climate change risk"
	c. Air pollution	"Contamination risk"
	d. Ozone layer	"Ozone layer risk"
	e. Acid rain	"Acid rain risk"
	f. Water contamination	"Water contamination risk"
	g. Acoustic pollution	"Acoustic contamination risk"
Environmental-natural	a. Earthquakes	"Earthquake risk"
	b. Floods/droughts	"Inundation risk" "Draught risk"
	c. Ultraviolet radiation	"Ultraviolet radiation risk"
	d. Storms / hurricanes / tornadoes	"Storm risk" "Hurricanes risk" "Tornadoes risk"
	e. Radon	"Radon risk"
Technological	a. Nuclear	"Nuclear risk"
	b. Chemical	"Chemical risk"
	c. Transgenic	"Transgenic risk"
	d. Wind	"Eolic risk"
	e. Waste	"Waste risk"
	f. Accidents	"Accident risk"
	g. Landfills	"Spill risk" "Dumping site risk"
	h. Wi-Fi	"Wi-Fi risk"
Biological	a. Viral diseases (Zika, Ebola, Tiger Mosquito)	"Viral illnesses risk" "Zika risk" "Ebola risk" "Tiger mosquito risk"
	b. Bacterial diseases	"Bacterial illnesses risk"
	c. Legionella/salmonellosis	"Legionella risk" "Salmonellosis risk"
	d. Vaccines	"Vaccine risk"

3.2. Measures

A coding protocol was created to register the various studied variables. We relied on three human coders for all the codification. In addition to coding, if the articles evoked emotions like awe or anger, coders quantified the extent to each article evoked these emotions. Coders received the title and the article's full text.

Before the start of the coding, a pilot test was developed in two phases to check the categories and the coders' accuracy. The first one consisted in the coding of 15 articles from both newspapers. After each coder completed these articles, the differences be-

tween the coders were discussed to establish a uniform coding methodology to reach a higher interrater reliability. A second pilot test was implemented with 5 more articles to improve the agreement of the methodology between coders.

Dependent variable

The dependent variable in the study is the number of times an article has been shared on social networks (Facebook, Twitter, etc.) and via e-mail. This number was obtained from the online version of the newspaper the day the article was stored.

Independent variables

The independent variables included variables to measure the characteristics of the risk and the emotions generated by the content of the article.

Regarding the type of risk, the *origin* of the risk refers to whether it is an environmental-anthropogenic, environmental-natural, technological or biological risk. The variable *specific risk* refers to the specific risk involved (climate change, floods, etc.). The variable *impact* registers whether the risk had an impact on people, ecosystems and/or infrastructure. Finally, the variable of the *geographical scope* was coded to locate the risk and its scope.

Eight variables were included to measure emotions (Table 3). First, *emotionality* measured the degree of positivism of the content. This is not necessarily marked by the type of risk, so an article about an intrinsically negative risk such as a flood can be positive, for example, if it shows the rescue of one or more people. The remaining variables were emotions such as *awe*, *anger*, *anxiety*, *sadness*, *practical utility*, *interest* and *surprise*. For each article, the coders registered to what extent the content evoked the emotion in a scale from 1-absolutely not at all/5-very much.

Table 3. List of variables

DEPENDENT VARIABLE	- **Number of times an article is shared**	Ratio scale

INDEPENDENT VARIABLES I (Risk characteristics)	- **Type of risk**
	  - **Origin**
	  - **Specific**
	- **Type of impact**
	- **Geographical scope**
	  - **Scope of the impact**
	  - **Location of the risk**
		Nominal scale

INDEPENDENT VARIABLES II (Content)	- **Emotions:**
	  - **Emotionality**
	  - **Awe**: is an emotion or self-transcendence, a feeling of admiration for something greater than the self. It involves the opening of the mind and an experience that makes you reflect.
	  - **Anger**: is a thrill representing a strong emotional response to a provocation, a damage or a perceived threat.
	  - **Anxiety**: is an emotion characterized by an unpleasant state of interior agitation, often accompanied by nervous behaviour.
	  - **Sadness**: is an emotional pain associated with or characterized by feelings of inferiority, failure, despair, affliction, helplessness, disappointment or melancholy.
	  - **Practical utility**: Useful information that brings the reader to a change in its behaviour.
	  - **Interest**: is an emotion causing attention to focus on an object, event or process.
	  - **Surprise**: is a brief mental and psychological state, a shock as a result of an unexpected event. Surprise can have any valence.
		Emotionality. Ordinal scale, from 1- (Strongly negative) to 5- (Strongly positive)
		
		All the emotions: Likert scale 1 (absolutely not) - 5 (extremely)

OTHER VARIABLES	- **Number of words** - **Newspaper** - **Section** - **Day** - **Month** - **Year** - **Hour of the day the article was published** - **Day of the week the article was published** - **Category of the article** (e.g., news, interview, video)	

Other measured **variables** consisted of the different external factors of attention that can affect the number of times a news item is shared by the readers. In this case, we observed the number of words of the article, the newspaper, the section, the date of publication, and the category, e.g. if it is a news article, an interview, etc. Including these controls allows the comparison of the relative impact of these external factors with the content characteristics (Berger & Milkman, 2012).

3.3. Analysis

With the pilot tests completed, the coders started to code the 200 articles. After all, coders finished and completed their code matrix; the matrix had been imported to IBM SPSS Statistics 21 to start the analysis. The analysis started with a descriptive analysis of all the variables, including the frequencies, the logarithms, histograms, Mood's median and correlations among other analysis.

4. Results

4.1. Hypothesis 0: Number of times an article is shared

In the case of the number of times a newspaper article is shared in social networks, there are some notable facts. First, the statistics for each newspaper report some differences to consider (Table 4).

Table 4. Descriptive statistics for the dependent variable

	Number of shares	
	Newspaper 1	Newspaper 2
Mean	366,14	140,02
Median	83,00	10,00
Mode	2	0
Range	5700	2537

In the case of "Newspaper 1", the average number of times a news article has been shared is 366.14 times and the median is 83, its mode is 2, and finally, the range is 5700, showing that the articles have been shared from 0 times to 5700 times. On the other hand, the "Newspaper 2" shows a mean of 140.02, a median of 10 and a range of 2537.

The following frequency charts, from both newspapers, show the number of times an article has been shared. In both graphs, we can see that most articles are shared rarely, while a few articles are shared on many occasions (Figure 2 and Figure 3). Thus, the two newspapers show a very similar pattern of behaviour.

Figure 2. Number of shares "Newspaper 1"

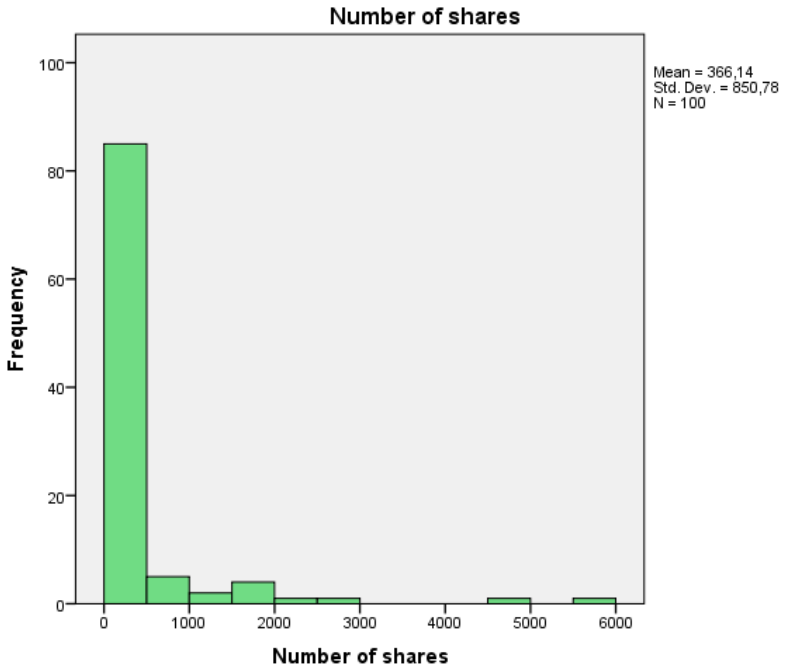
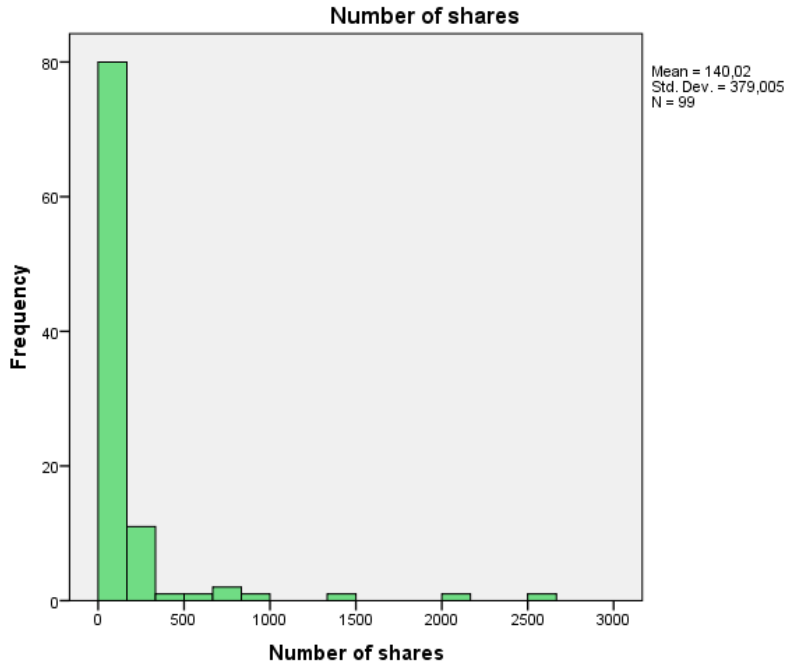


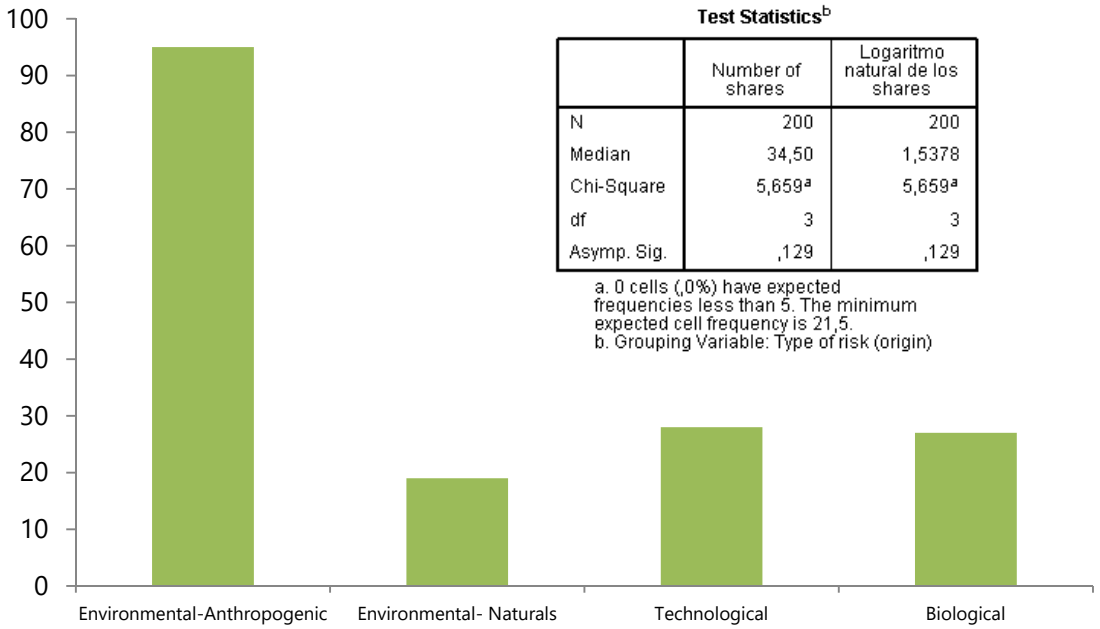
Figure 3. Number of shares "Newspapers 2"



4.2. Hypothesis 1: Risk characteristics

As for the first hypothesis, that is, the characteristics of the risk content, we can start observing the median number of times a story has been shared (Figure 4). Thus, the median shows us how environmental-anthropogenic risks tend to be shared more than the rest, with environmental-natural risks being the less shared. Even so, as we can see in the statistics, these differences are not statistically significant.

Figure 4. Median number of shares



Test Statistics[b]

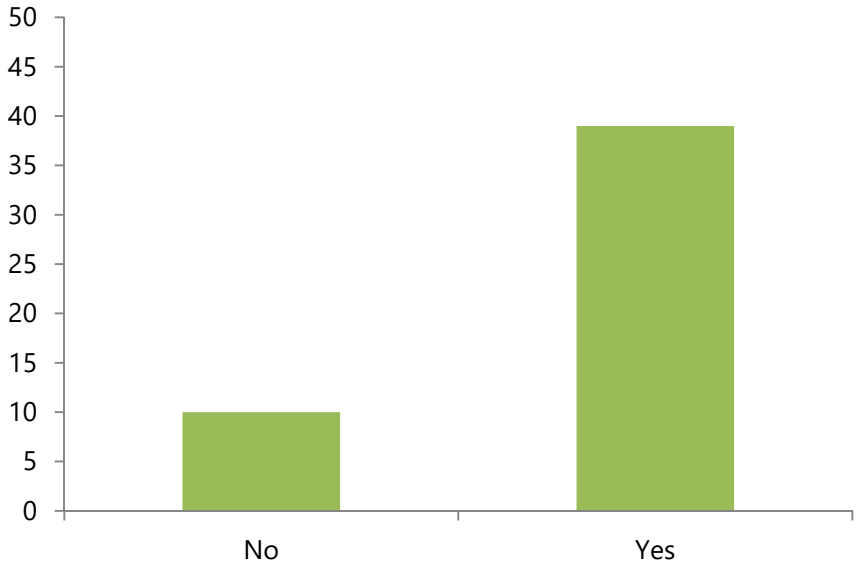
	Number of shares	Logaritmo natural de los shares
N	200	200
Median	34,50	1,5378
Chi-Square	5,659[a]	5,659[a]
df	3	3
Asymp. Sig.	,129	,129

a. 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 21,5.
b. Grouping Variable: Type of risk (origin)

4.2.1. Type of impact

In the case of the typology of the impact, the risks having a clear impact on people tend to be shared more frequently than those not having an impact on people, although the difference is not statistically significant (median test) (Figure 5).

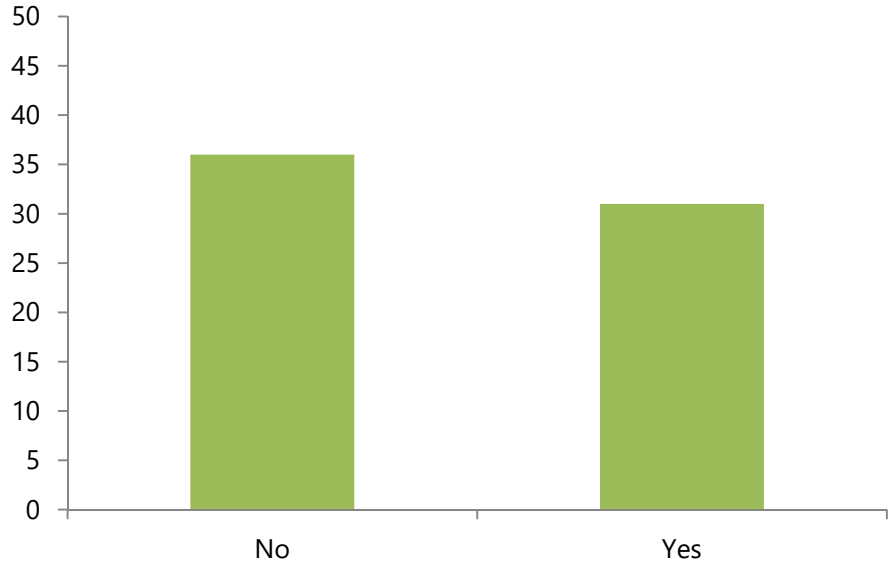
Figure 5. Impact on people (median)



Chi-square: 1.80 p= 0.179

Figure 6 shows the median number of shares for news articles depending on whether the risk has an impact on ecosystems. The difference is not relevant and non-statistically significant.

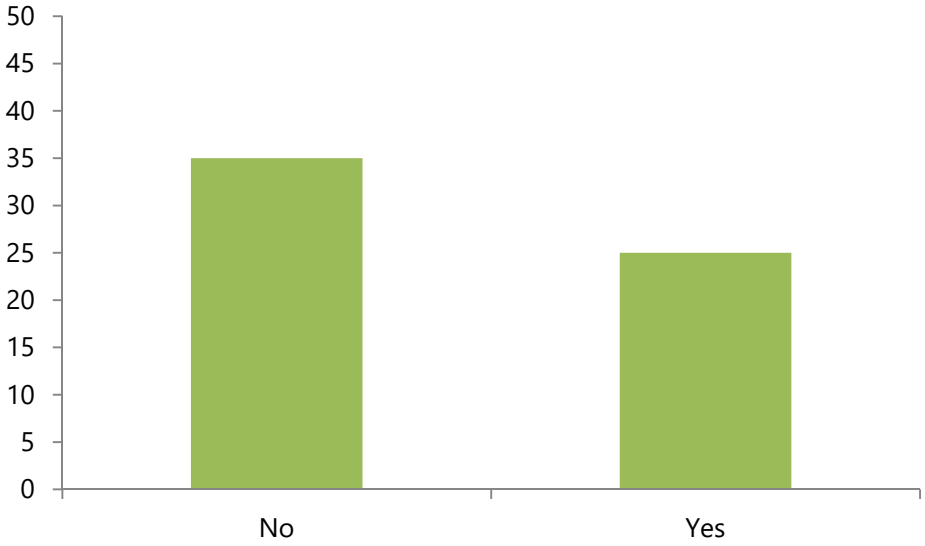
Figure 6. Impact on ecosystems (median)



Chi-square: 0.088 p= 0.76

As for the impacts on infrastructure, the news that shows impacts on it tends to be less shared (Figure 7). The differences are not statistically significant.

Figure 7. Impact on infrastructure (median)

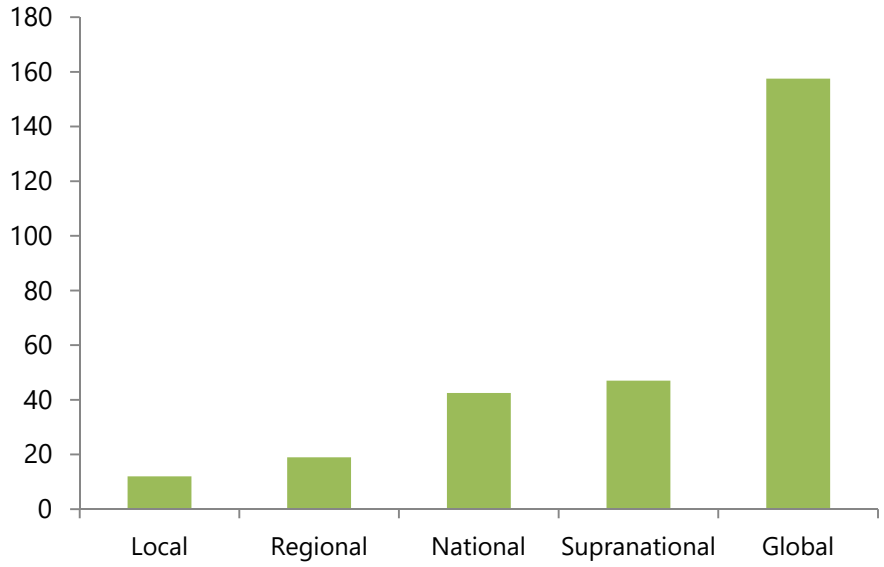


Chi-square: 0.03 P= 0.86

4.2.2. Geographical impact

The scope of the impact of the risk, whether the risk has, according to the article, a local, regional, national, supranational or global impact is significantly associated to the number of times the article is shared (*¡Error! La autoreferencia al marcador no es válida.*). Specifically, content about risks that have a global impact is significantly more shared that those about risks with a local or national impact.

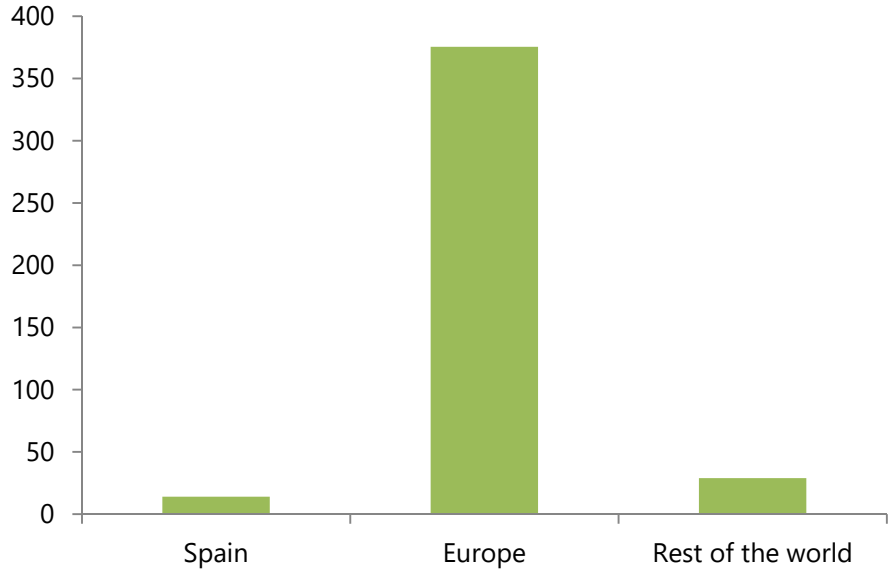
Figure 8. Scope of the impact (mean)



p= 0.001

In the case of the location of the risk (Figure 9), it is determined whether the geographical scope outlined above is in Spain, in Europe or elsewhere in the world.

Figure 9. Location of the risk



p= 0.02

As can be seen, there are significant differences depending on the geographical scope of the risk.

4.3. Hypothesis 2: Emotions of the content

Table 5 shows the correlation between the emotions generated by the content and the number of times a story is shared online. The data show that *emotionality* (-.178) is negatively correlated to virality, meaning that the negative articles are more shared than the positive ones. On the other hand, *anxiety* (.324) is the best predictor of the number of shares an article has. The other emotions that are associated with virality are *interest* (.274), *surprise* (.255), *practical utility* (.235) and *awe* (.143). Anger and sadness are not significantly associated with the transmission of the information.

Table 5. Correlation coefficient for the studied variables (Spearman's Rho)

	Number of shares
Emotionality	-.178*
Awe	.143*
Anger	.079
Anxiety	.324*
Sadness	.086
Practical utility	.235*
Interest	.274*
Surprise	.255*

N=200

** The correlation is significant at a 0.05 level*

5. Discussion

The main objective of this study has been to examine the mechanisms that cause certain newspaper articles about environmental and technological risks to be more or less shared among individuals in Internet social network communities. Specifically, the research question investigated was: to what extent do the emotionality of the content of the information about the risk and the characteristics of the risk (type, impact and scope) determine the social transmission of the information about the risk?

First, we examined to what extent news articles about risks (environmental, technological and biological) are shared. Our data show that the informal transmission of the online content about risk issues follows a very asymmetrical distribution: a majority of the articles about risk issues are not frequently shared by readers, while a few of them have a very high social transmission. There is a minority of popular articles and a majority of non-popular articles.

In order to understand why certain pieces of online content are more viral than others, we first examined the impact of the characteristics of the risk (type of risk, impact and geographical scope). The results show that the risk characteristics have a moderate influence on the transmission of the content, but this effect appears to be statistically non-significant for most of the studied variables. News articles covering environmental-anthropogenic risks (such as air pollution or climate change) tend to be transmitted more frequently than those articles covering natural, technological or biological risks. Also, articles covering risks with a global scope are more frequently transmitted than those with a local or national scope.

One likely interpretation is that news articles covering environmental-anthropogenic risks tend to generate more anxiety, interest or surprise. Although not covered in this report, our analysis shows that the content on environmental-anthropogenic risks tends to be significantly more negative and to generate more anxiety than the content covering other types of risks (differences are weak to moderate). Part of the explanation may also lie in the fact that individuals might perceive topics such as climate change or air pollution as more popular than other risks and so be more prone to share this content.

Second, we examined the impact of the emotionality of the content on social transmission. The data show that the emotions generated by the content are significantly associated with the virality of the newspaper articles. The contents that produce more anxiety are shared to a greater extent. Contents with a more negative emotionality tend to be shared more frequently. Also, articles that generate more interest, surprise and practical utility are more frequently shared among individuals online.

Our data is in line with similar studies by Berger & Milkman (2012): the emotions generated by the news content condition their virality, with a greater or lesser impact depending on the emotions evoked. In this sense, the transmission of content about environmental and technological risks seems to have a similar pattern to that observed in online general content. Emotions characterized by activation or arousal (i.e., anxiety and surprise) are positively linked to virality, while emotions characterized by deactivation (i.e., sadness) are negatively linked to virality. Contents generating interest and providing some practical utility are also positively linked to virality. However, contrary to Berger and Milkman (2012), our data show that negative content is more viral than positive content. The results are consistent with Hansen et al. (2011), who found that when messages in Twitter contain news, if these news are more negative, the message is shared to a greater extent. Content about risk issues seems, according to our data, to follow a similar pattern. Negative newspaper articles are more viral.

Overall, this study suggests that social amplification of risks processes (Kasperson et al., 1988) might also be influenced by content characteristics (e.g., whether an article about risk issues is positive or awe-inspiring). Informal transmission of information can raise awareness of an issue and generate changes in the beliefs, attitudes and intentions of the behaviour of individuals (L. J. Frewer, Miles, & Marsh, 2002; L. Frewer et al., 2004). And, as our study shows, in line with previous research, informal transmission of information, at least in its written form, is partially determined by content characteristics of the information. Independently of the type of risk and the diverse set of external sociopolitical factors influencing social amplification of risk, this work suggests that certain characteristics of content, such as the emotion (and activation) that content evokes also help determine which risk issues gain attention in the public debate.

There are some limitations in our study. One of the limitations is related to the sample. We selected two newspapers that provide information regarding the number of shares (our dependent variable). This can induce a bias because certain newspapers might have a certain type of readers in terms of their sociodemographic characteristics. One potential source of error regarding the data set is related to the difference in the number of readers and therefore of shares between the two newspapers, which could be problematic if the two newspapers focus on different types of risk (we somehow controlled this by having similar types of articles in both subsamples). One easy solution would have been to collect a sample of articles from only one newspaper, so the number of readers and, therefore, the average number of shares, would have been controlled. Another thing to look out is the difference between social networks. Although we codified all of them in the same way, is not the same to share an article on Facebook, or Twitter or in another social network (Berger & Iyengar, 2013).

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1135-9420