

Research Article

Digital Outburst: The Expression of a Social Crisis through Online Social Networks

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There is a growing concern about the effects that the relationship between the activity of society in the physical world and in the digital world could have. In this study, we address this question in a context of social crisis. Our quantitative and qualitative analysis of the data associated with the critical process suggests a deep and nontrivial relationship between both worlds. Perhaps the most important result refers to the leading role of language, its meaning, and symbolism in the development of social transformation processes linked to the complexity of the social system and its adaptive nature.

1. Introduction

Victor Hugo, the great French writer and political activist, lived through troubled social times. He was convinced that his country needed drastic social changes. The abolition of the monarchy and, in its replacement, the arrival of the republic, represented that change in social organization that he, along with many others, considered necessary. His famous phrase “Nothing is more powerful than an idea whose time has come” gave collective ideas a leading role and immense transformative potential. Relegating individuals to a secondary role is useful as vehicles for their propagation and execution.

This scenario represents one of the many moments in which human societies have faced crisis processes. Although the pressures for change, articulated in collective ideas that are manifested in language games, are of different nature and context-dependent. They represent a common mechanism

behind social crises: they operate as pressures so that the system adapts to new social needs or challenges [1, 2]. These social processes unveil evolutionary properties of the system that emerge from adaptive demands without previous purposes, related to the survival of the social system itself [3, 4]. Evidencing a sort of endogenous restlessness of the system, permanently willing to reproduce the differentiation and diversity of social meanings.

From the complex systems theory, the dynamic and evolutionary nature of societies, which produces this differentiation and diversity and which inevitably pushes the social system to processes of adaptations–innovations and therefore of crisis, is framed within the scope of the so-called “complex adaptive systems” (CAS) [5, 6]. These types of systems, composed of multiple components with nontrivial dependency and affectation interactions, manifest a wide range of possible behaviors, which defines them as “complex” [7]. However, its main characteristic is its ability to

incorporate, spontaneously during its evolutionary history, information (i.e., complexity) as a result of their interaction with the environment, in order to function in an environment that demands new capabilities. Thus, in the evolutionary history of a CAS, the past is characterized by a lower level of information or complexity than in a future state [8].

The interesting thing is that the same complexity acquired by the system, by diversifying the roles of its components and improving their combination, begins to exert pressure for the system to incorporate it into its functional order. The above would also be valid for human societies. The complexity acquired by the social system, translated into the creation of new norms, bureaucracy, infrastructure, social values, institutionalism, among other adjustments, has an associated cost that may contribute to the destabilization of the system [9]. Thus, complexity, crisis and evolution are closely related concepts in the history of human organizations, giving crisis a natural, collective, and necessary character for the system's evolution. This vision enriches the important contribution of the social sciences to the understanding of the phenomenon whose thinkers have focused on the identification of certain conditions behind the social crises. According to Marx [10], the cause of social conflict lay in the unequal distribution of private ownership of production goods, the origin of the domination of some over others. Weber [11] agrees that the origin of the conflict is at the level of the economy, but without the character or scope that Marx gives it. Coser [12] introduces the concept of "relative deprivation" as a conditioning factor of social mobilizations and violence. Dahrendorf [13] installs the unequal distribution of authority as the cause of contemporary social conflict. For Kornhauser [14], the problem lies in the conflictive relationship between the elite and the nonelite. For Touraine [15], the phenomenon of conflict is linked to the "technocracy" which, as the new ruling class, ends up imposing its ideas. Foucault [16] believes that the origin of the conflict is in a relationship of domination that is constantly created in social bonds (in the microphysics of power). Habermas [17] sees the origin of social conflict in the absence of consensus in society. While Lyotard [18] characterized postmodernity as part of a process of sociocultural mutation that has led to the collapse of the historical project of modernity, creating conditions of permanent social instability. For del Rey Moratto [19], the conditions for the conflict are provided by the power of language. Within this group, the ideas of Luhmann [20] and Dobry [21] stand out by incorporating certain aspects of complex systems.

The traumatic experience of Victor Hugo, exiled between 1852 and 1870 for defending those transformative ideas in his time, is revived today in many places around the world. For some years now, countries in different continents have been facing deep social crises that demand common transformations, advocating for better living conditions, equality, justice, among others. In fact, between 2018 and 2020, there are around 42 countries that had major social disruptions [22]. Chile, within these countries, can be considered a paradigmatic case. Its history is characterized by various social crises (in the years 1810, 1818, 1833, 1891, 1924, and 1973) that have determined changes and

transformations in the organization of social, political, and economic systems.

Today, as in the past, Chile is going through a profound crisis characterized by one of the largest expressions worldwide regarding the number of events associated with social crisis, the number of people involved, and the duration of the process [23]. According to Roberts [24], the present situation went from a state of stability or a state of routine conjuncture according to Dobry [21], since the end of the military dictatorship in 1990, to a state of crisis or fluid critical conjuncture, with the so-called "penguin revolution" in 2006. The "Chilean miracle," praised in much of the world during the 1990s, began to suffer when a series of adaptation pressures formed a critical mass demanding a new order, or a new social contract according to Rousseau's ideas [25–27]. The language game of the Chilean crisis embraced social valuations such as probity, transparency, gender, feminism, environment, among others, which reflect the internalization of global social valuations and others of their own. They started to put pressure on the order established up to that moment causing a functional differentiation and diversity (with expressions of social fragmentariness) self-organized around diverse interests of social collectives whose identity contours were constructed and perceived according to the meaning they acquired and assigned [4].

1.1. New Information Technologies and Social Crises. Chilean social pressure coincided with the massive irruption of information technologies as a form of social communication. Some works on the relationship between new forms of information/communication and social crises indicate the concern of epistemic public crises that may impact the political spheres. This phenomenon is due to the quantity and speed of information production and the forms of knowledge construction due to digital technologies [28] and, also, the emerging dynamics of digital network recruitment that has been observed in mass protests [29].

Thus, as in other countries, the new information technologies became platforms where dissent occurred regarding the rules of social functioning established in recent decades. Little by little, the Internet, and its online social networking applications, helped the propagation of these ideas by eliminating geographical and temporal barriers. Generating an environment whose "social temperature" began to increase and exploded on October 18, 2019 (18-O). It ended up by breaking part of the sociopolitical structure of the country, the result is still underdevelopment.

18-O was preceded by a series of unfortunate statements from government officials and by an increase in the value of public transportation (subway) in the country's capital. High school students responded to the increase with evasion of the charge [30]. Triggering an escalation of evasion that derived on October 18 in different forms of multisectoral manifestations and social violence unprecedented in the country. The panorama that the country experienced for several days included marches, pot-banging, burning of subway stations, looting, destruction, and a questioned police response.

That social outburst, as a critical salient of the Chilean social crisis, had a milestone on the night of November 15, 2019, when in a transversal agreement of Parliament, as a way to institutionalize the conflict, the so-called “Agreement for Social Peace and New Constitution” (Acuerdo por la Paz Social y la Nueva Constitución), ASPNC, was generated. In it there was an agreement to rewrite the Chilean Constitution through a Constituent Convention mechanism [31–33].

The new social organization, demanded by social events of different types that had been occurring since 2006 and that exploded in October 2019, is materialized, potentially, in this agreement as an emerging property of the collective. Which is the product of the multiple interactions between ideas, thoughts, feelings, and actions of the individuals that make up the country.

This research is inserted in the context described above, particularly, in the study and analysis of the Chilean social outburst, as climax of the social crisis, and in the institutionalization of this conflict in the milestone of ASPNC as a social adaptation to the crisis. The study aims to contribute with a description of the phenomenon of social crises from the perspective of complex systems, in particular, from its adaptive nature. This research assumes the social system as one of complex and adaptive character; therefore, subject to certain fundamental laws that operate within and on them. Although it is not the purpose of this work to deepen in these, but rather to demonstrate its manifestation.

1.2. Hypothesis and Objectives. The research is based on the following hypotheses: (i) part of the complexity of a social system is expressed in the social contract that it generated and that defines its identity dynamically; (ii) this social contract enters into dissent (Crisis) when ideas, thoughts, feelings, and actions of its social agents operate as adaptation pressures in search of a new order (i.e., new social contract); (iii) these adaptation pressures and the possible resulting scenarios (i.e., new social contract) can be observed from the activity of the society in cyberspace, being a reflection of what happens in the material society (activity of society in physical space).

This work focuses on the transformative potential of collective ideas, thoughts, feelings, and actions, and on the capacity of the digital environment to guide these processes through the use of language represented by hot topics (Trending Topics) that circulate in digital circuits as a projection of these ideas, thoughts, feelings, and actions of the components of the social system. To validate these hypotheses, the research has specific objectives: (i) unveil manifestations of the complexity phenomenon from the digital society, before and during the Chilean social outburst; (ii) study the correlation between social events and their expression in online social networks before and during the social outburst; (iii) explore possible causal relationships between material and digital social expressions in times of crisis and, finally; (iv) characterize the events associated to social outbursts as well as the relationships between actors (agents and affected) by these events.

The study is structured as follows: Section 2 describes the quantitative and qualitative methodology used for the analysis of the Chilean social outburst that affected the country during the months of October and November 2019. Section 3 presents the results obtained from the developed analysis. In this section, the results are divided into three parts: (i) changes detected in digital behavior before and during the social outburst; (ii) analysis of social behavior, both material and digital, during the social outburst; and (iii) analysis on causality between the material and digital activity of Chilean society. Section 4 presents a discussion of the results obtained and their interpretation according to the proposed model of social crisis. Section 5 presents the main conclusions drawn from this work.

2. Methodology

2.1. Period Studied. To address the process of transformation and social adaptation of Chilean society, and its expression in online social networks, we analyzed the period from September 1 to November 15, 2019. This period covers the three most critical days of the social outbreak (red), 48 days before (blue) and 26 days after (green), which culminated with the milestone ASPNC (Figure 1). It is important to note that the separation of the outbreak into two parts (red and green) is due only to the particularity of the social behavior manifested in the first three days of the outbreak, but in no case does it mean that the outbreak has ended after those first three days.

2.2. Correlation Analysis between the Material Society and the Digital Society. A quantitative and qualitative analysis of the social events that occurred during the studied period and their correlation with the digital social expression of these events on the online social network Twitter was made.

To determine the social events during the period under study to be analyzed, an automatic extraction from Google, every day and throughout the period (Table 1), of news published by the main Chilean media according to the classification of Digital New Report (2020)1.

The period from October 4 to November 15, 2019 (hatched area Figure 1) used as a basis the list of events of sociopolitical character described in [23], subsequently complemented with the main news/events associated, collected from the main Chilean media according to Digital News Report (2020). In order to analyze only those events with sociopolitical character in the previous period, between September 1 and October 4, 2019, a classification of the news was performed leaving aside those with international character, entertainment, sports, and others (Table 1).

For the period from October 4 to November 15, 2019 (hatched area Figure 1), a categorical content analysis [34] was also performed, which allowed classifying each of the 817 news/events of that period into five categories, which are also subdivided into subcategories (Table 2).

Correlation between events and digital activity. To determine the correlation between the events analyzed and Twitter activity, all the Trending Topics (TT) [35] associated

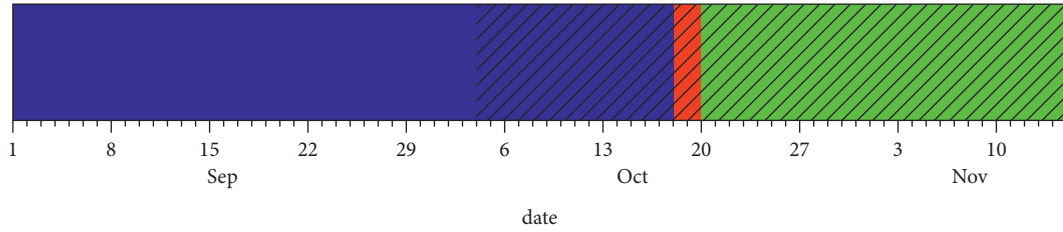


FIGURE 1: Period studied. Blue region corresponds to the period prior to the Chilean social outbreak. Red region corresponds to the first three days of the social outbreak. Green region corresponds to the period after those three days that culminates with the milestone ASPNC. Hatched area corresponds to the period used as a basis for the list of sociopolitical events described in [23].

TABLE 1: Number of News and Trending topics used in the analysis corresponding to the period studied divided into two stages: before the Social Outbreak (48 days) and during the Social Outbreak (29 days).

	Before	During	Total
News/events	2659	1012	3671
News/events sociopolitical character	533	817	1350
Trending topics (unique)	5553	4359	9912

TABLE 2: Description of the analysis categories for the news/events during the Chilean social outbreak.

Category	Definition	Subcategory
Agent	Social sector from where the action described in the news or event is exercised.	Art, culture, and entertainment; citizenship, sports, entrepreneurship, armed forces (AF), forces of order and security (FOS), government, national media, international media, international organizations, private organizations, public organizations, social organizations, others, political party, judicial branch, legislative branch, services.
Affected	What or who receives the action described in the news or event.	The same subcategories as in agent category, plus events, goods, and services.
Territory	Geographical location where the news or event studied takes place.	Country, international, different cities in Chile (e.g.: Valparaíso, santiago, temuco).
Type of relationship	How to characterize the agent-affected relationship, from the affected person's reaction.	Synergistic or conflictive.
Type of event	Characterization of the pattern of the event or news based on the main action that is described.	Constitutional accusation, social support, search for consensus, controversial behavior, control, unprecedented control, internal control FA or FOS, damage to goods and/or services, report human rights violations, detention of FA or FOS members, demand for the cessation of violence, event management, service management, FA or FOS impunity, social mobilization, reparation, police repression, violence.

with Chile for each day of the period studied were extracted from the Trendinalia database (<https://www.trendinalia.com/>), as well as the duration (minutes) of each one (Table 1). Once the TTs were extracted, automatic processing was carried out to determine the presence of the TT in the headline of the news, in its content, or in the agent or person affected by the event. Finally, the degree of correlation between these events and the digital social activity was performed by considering the presence (Twitter match) and the duration of the correlated TT.

Causality analysis between digital and material activity in society. To address the possible causal relationships between society's digital and material activities, we used a procedure that is similar to the one described above (Twitter match). In this case considering the presence of

TT the days before/after the day of the analyzed event. Two types of (potential) causality relationships were obtained when: (i) Twitter conditions a material event (i.e., there is Twitter match between the day of an event with a TT of the previous day), or when, (ii) the material event conditions the reaction on Twitter (i.e., there is Twitter match between the day of an event with a TT of the following day).

Given the number of events during the most critical days of the social outburst, as well as the dissemination of information in various media, this methodology is not entirely accurate. For this reason, the milestone ASPNC and the accusations made against government officials during the social outburst were used to test the relationship between both the worlds digital and material.

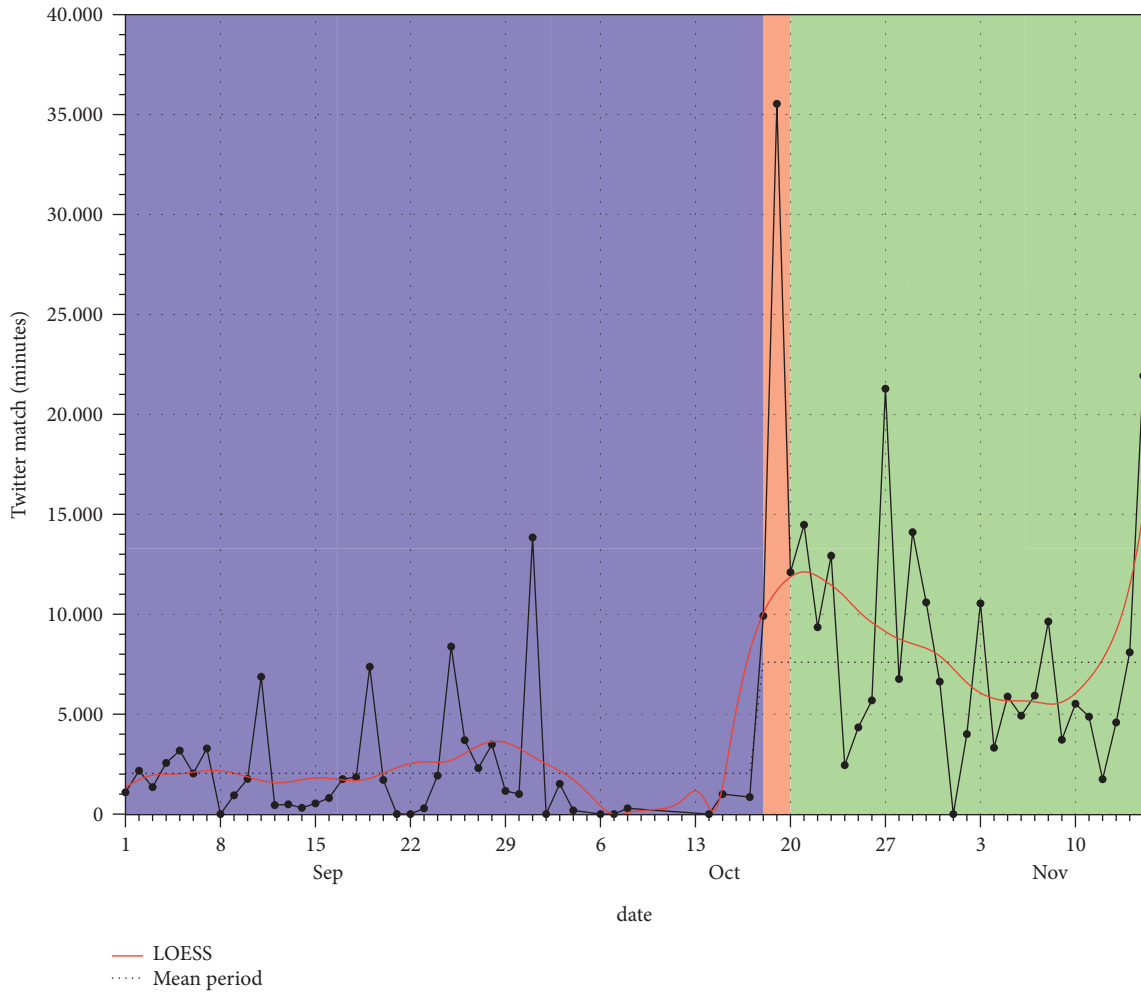


FIGURE 2: Relationship between “social events” that appear in digital media and their appearance on Twitter as Trending Topics. Vertical axis corresponds to the duration of those TTs that were associated with the events described in the digital media.

2.3. Analysis of Social Complexity. Two models were created to quantify the dynamics of the complexity of the Chilean social system during the social outburst: (i) System of Ideas and (ii) System of Actors. The system of ideas reflects the dynamics of relationships between the type of concepts that transited in the digital society during the studied period. The system of actors represents the dynamics of relationships between actors (agents and affected) during the social outburst. Changes in social complexity depend on changes in the structure of relationships between the entities of both systems.

System of Ideas. The graph $I(T, E)$ is defined as an undirected network of ideas composed by T trending topics and E links between them. The relationship e_{ij} between trending topics i and j occurs when both cooccur on the same day. Thus, for day d , I_d will correspond to a clique network where all the TTs of that day are linked to each other because they cooccur on the same day d .

Two I networks were constructed to analyze their structure and determine the complexity of these systems of ideas before and after the social outburst. I_a corresponds to the network accumulated during the preoutburst period

from September 1 to October 17, 2019. If a TT i appears on more than one day during this period, different daily networks will be related. The same procedure was performed for the postburst period from October 18 to November 15, 2019.

The frequency of appearance of a TT i on different days, as well as the frequency of relationships between trending topics i and j on different days, will define attributes for nodes and links, respectively, which will be considered in the analysis. The study of the structure of these networks was complemented with a classification of these TT in different categories.

System of Actors. The graph $A(N, R)$ is defined as a network of actors composed by N agents/affected and R relationships between them. The relationships between actors i and j is directed, that is, from agent (i) to affected (j). The frequency of relationships between actors i and j in different days of the studied period will define the attributes for the nodes and links which will be considered in the analyses. The study of the structure of these networks was complemented with a classification of these actors into different categories (see Table 2).

3. Results

The results of this research are divided into three parts. The first one refers to the results of the analysis that allows us to show the differences in the behavior of the digital society before and after the social outburst. The second one refers to the analysis of social behavior, both material and digital, during the social outburst. Finally, there is a section referring to causal relationships between digital and material activity of society.

3.1. Digital Behavior before and during the Social Explosion. Figure 2 shows the correlation between material and digital societies using the concept Twitter match. In this study, a Twitter match is defined when a material social event has its manifestation on Twitter. The figure shows that during the period before the social outburst (blue region), very few events of a sociopolitical nature had a correlation with Twitter's social activity. These changes completely after the first 3 days of the social outburst. During this period, Twitter becomes a much more sociopolitical platform where the majority of the "material" events associated with the outburst have a manifestation in society's digital activity.

Figure 3 shows other changes in the behavior of digital society before and during the outburst. The lower plot shows the amount of daily TTs before and during the social outburst. Before the social outburst, there was an average of close to 250 daily TTs for Chile. However, during the outburst, this number was very variable and, on average, with less daily TTs. On the other hand, the TTs of a sociopolitical nature increased considerably during the outburst in a clear sign of connection between the digital society and what was happening in the streets of the country (Figure 3, middle plot). There are no significant differences between the two periods in the average duration (minutes) of the TTs in each day.

The stronger connection between material and digital societies during the burst was manifested first by a stronger correlation between events associated with the social outburst and digital activity (Figure 2) and by the sociopolitical character that the digitized society acquires (Figure 3). Figure 4 suggests an even deeper change in digital behavior during the burst.

Before the social explosion (Figure 4, left), 49% of the TTs referred to Entertainment (*E*) and Sports (*G*). The International topic was the third most represented category ($I=16\%$), followed by Political (*P*), which, together with Social (*S*), accounted for only 20% of the hot topics on the digital social network. However, during the social outburst (Figure 4, right), social and political contributed with 47% of the TTs, while entertainment and sports, together, reached only 21%, whereas international fell to a 9% of representation, showing a clear change in the topics that began to be discussed digitally once the digital explosion began.

This change can also be seen in another way. If we consider the different categories of TTs as the space of possibilities in which the digital social system can manifest

itself, we can understand this change as a new form of organization of the digital society. As mentioned, before the social outburst, entertainment and sports dominated the social network landscape, but not only in terms of number of TTs but also considering the time these remained as such.

Figure 5 shows that after the social outburst started, the thematic diversity is greater when considering the number and duration of TTs. This translates into a higher entropy (*S*) of the system during the social outburst.

Finally, regarding the relationship between the topics that dominated Twitter's digital society, Figure 6 shows clear differences before and during the social outburst. The figure highlights the above described where before the outburst (left network), the main nodes correspond to entertainment and sports (node size proportional to the number of associated TT), while after the beginning of the outburst, social and political take prominence. However, the networks also show something else. While before the outbreak, only 1% of the TT relationships were between social and political, after the outbreak began, these relationships increased to 12%, that is, after the social revolt began, both types of hot topics appear together in digital society. On the other hand, before the social outburst, political and social topics appear weakly associated with other type of topics with low relevance (category Others) such as dates, places, international trending topics, while after the beginning of the social outburst, 33% of the social and political hot topics appear linked to the category Others. Denoting the transversal character that these categories acquire during the social outburst.

3.2. Digital Behavior during the Social Explosion. Digital behavior during the first days of the social explosion. The period of 3 days from the beginning of the outburst requires a particular analysis. This period is characterized by an anomalous behavior, when comparing it to the presocial outburst period, and to the period following these first 3 days of revolt. Figure 7 shows the probability distribution of TT duration before (blue), after (green), and during (red) the three peak days of the social outburst.

Before and after these 3 days, the probability distribution shows a similar behavior with a 2-hour mode, i.e., before and after the burst, it is most likely to find hot topics that are maintained for 2 hours. However, during the first 3 days of the outbreak, the most probable modal duration is less than 1 hour. This indicates that during this period there was a frequent renewal, a high diffusion of hot topics where none managed to establish itself as the dominant topic, which is consistent with the social activity of those days where information flowed in a massive, disorderly, and imprecise way. The particular behavior of those days is evident when comparing the probability distribution of periods with the same duration (3 days) in prior months (August and September 2019) to the social outburst (Figure 7, inset).

One possible way to conceptually understand the above described is by means of a stochastic growth and decay model of the Lotka–Volterra type. This model has been used and discussed for innovation adoption analysis [36, 37]. In

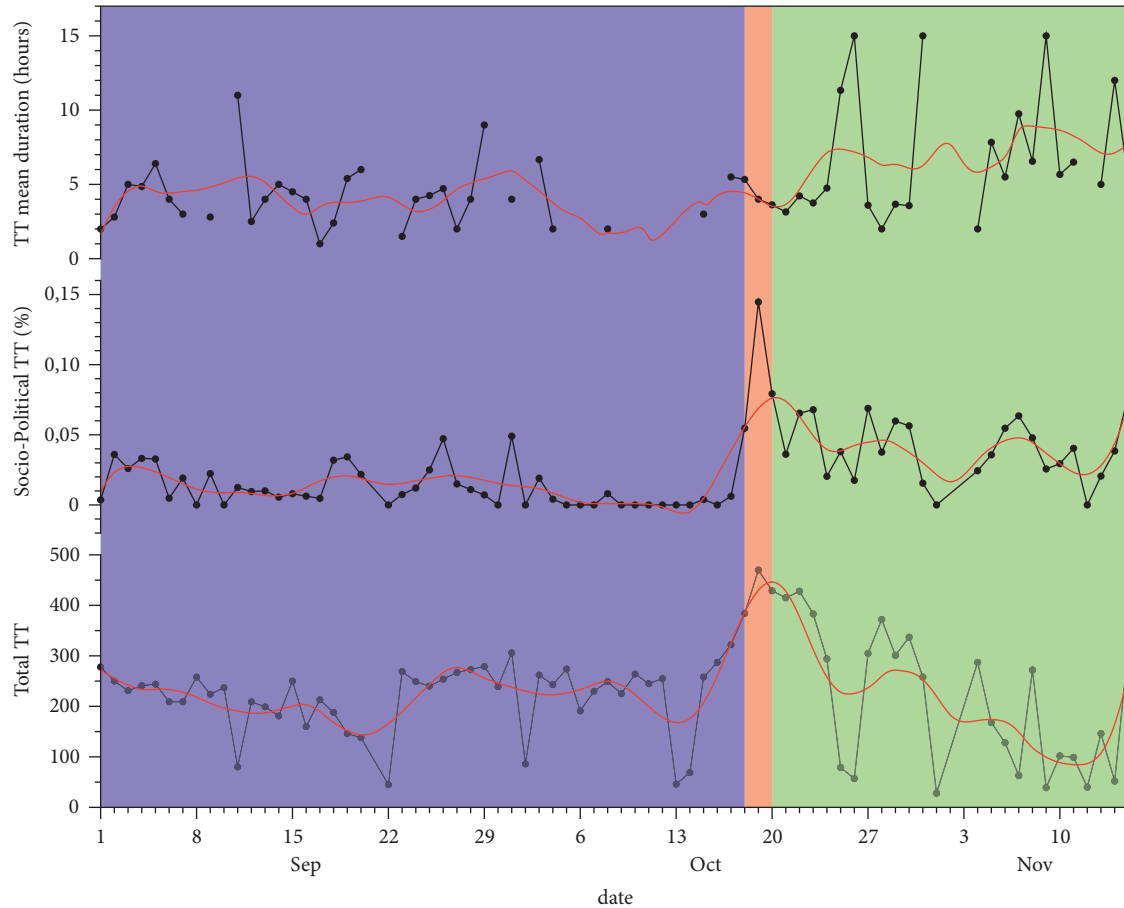


FIGURE 3: Bottom: amount of total TTs before, during (red band) and after the burst. Middle: number of TT with “social relationship” (qualitative analysis). Top: average duration of TTs before, during (red band) and after the outbreak.

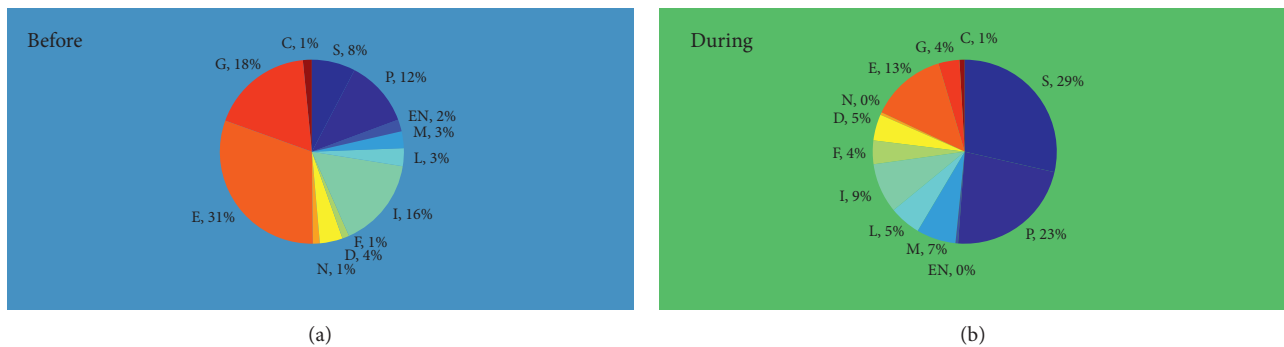


FIGURE 4: Distribution of TT categories before (left) and during (right) the social outbreak. D = date, P = political, S = social, M = media, E = entertainment, I = international, G = sport, EN = environment, L = place, C = commerce, F = police, army, others, N = natural event.

this particular case, we will use it to understand the adoption of trending topics in the digital community.

We insist that this model does not seek to understand in detail the dynamics and the different aspects of it. However, we believe it is a good way to understand without much paraphernalia the relevant aspects for this discussion:

$$d_t x = (g + e)x - q x^2. \quad (1)$$

Here g is the speed of TT creation, e is a stochastic variable that accounts for the random process in the creation of TT (we will consider it Gaussian, uncorrelated, and of variance $2D$), this mechanism will be important in disruption times. On the other hand, q is a decaying process in the production of TT. It can be proved [38] that the stationary distribution of the process in (1) will be

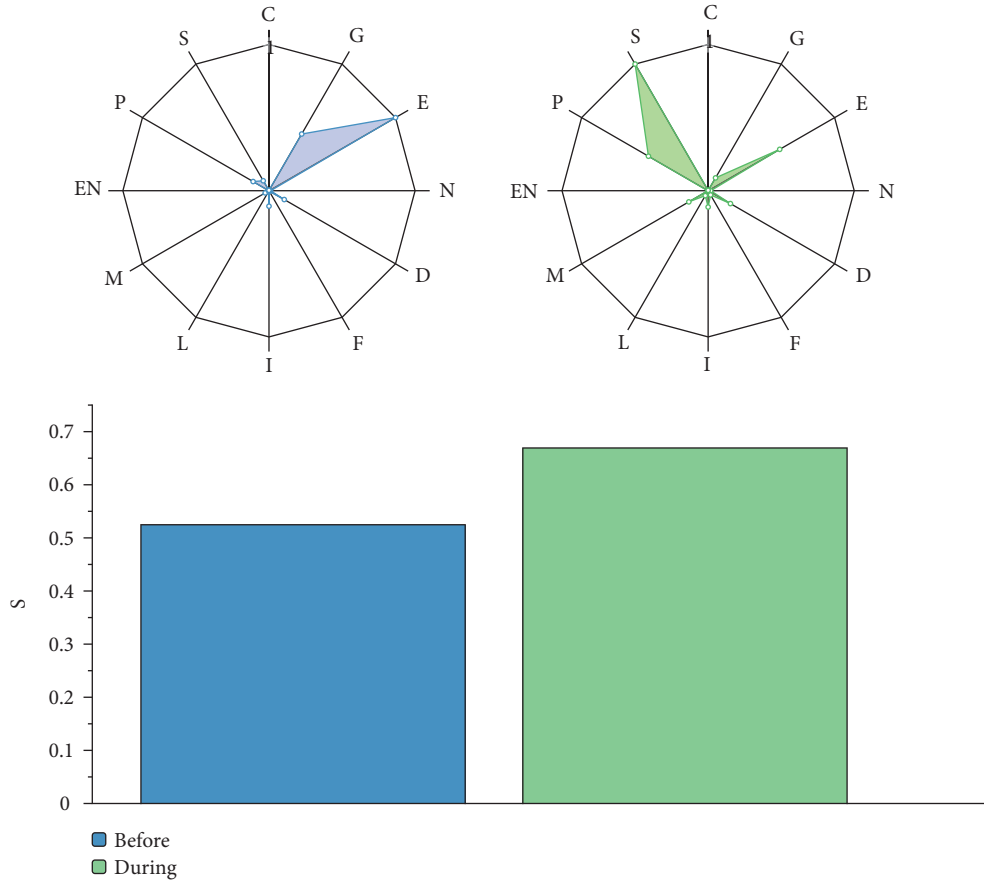


FIGURE 5: Use of the communication categories space before and during the social outbreak. Entropy (S).

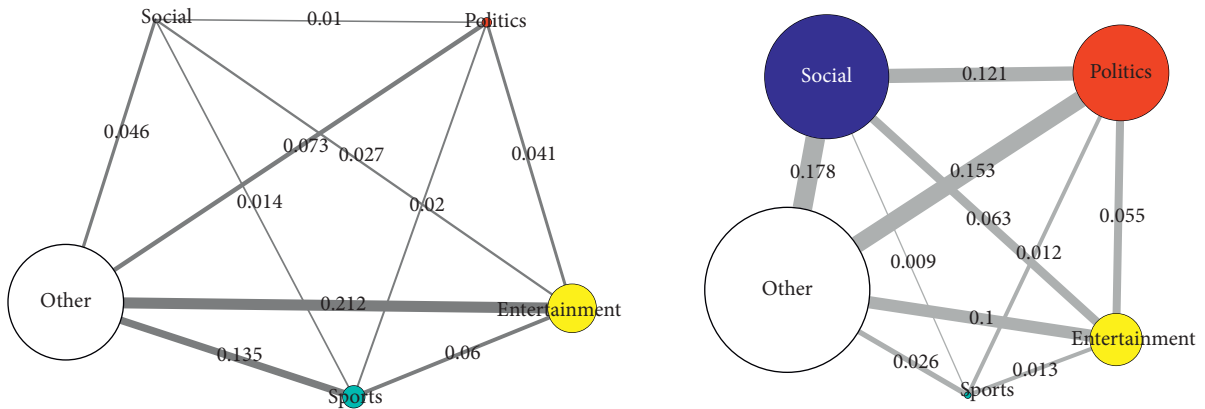


FIGURE 6: Network of ideas I(T, E) before and after the social outbreak. The value of links that represents the frequency of relationship are normalized. The size of the nodes represents the number of TTs belonging to those categories.

$$p(x) = \frac{b^a}{\Gamma(a)} x^{a-1} e^{-x}, \text{ with } a = \frac{g}{D} \text{ and } b = \frac{q}{D}. \quad (2)$$

We can see that changes in the agitation of the discussion (increasing in D), together with an increase in the decay of topic adoption, resulting from the much more active flow of information, in agitated moments, can account for the characteristics shown by the empirical data (see Figures 7 and 8). We emphasize that the discussion of this model is

beyond the scope of the present work, but we show the type of dynamic analysis that can be used to understand the changing characteristics of the TT duration distribution.

Relations between actors during the social outbreak. During the Chilean social outbreak, a series of actors, both agents and affected (Table 2), played a leading role in the actions of the material society. Figure 9 shows the synergistic relationships between the actors involved in the social outbreak.

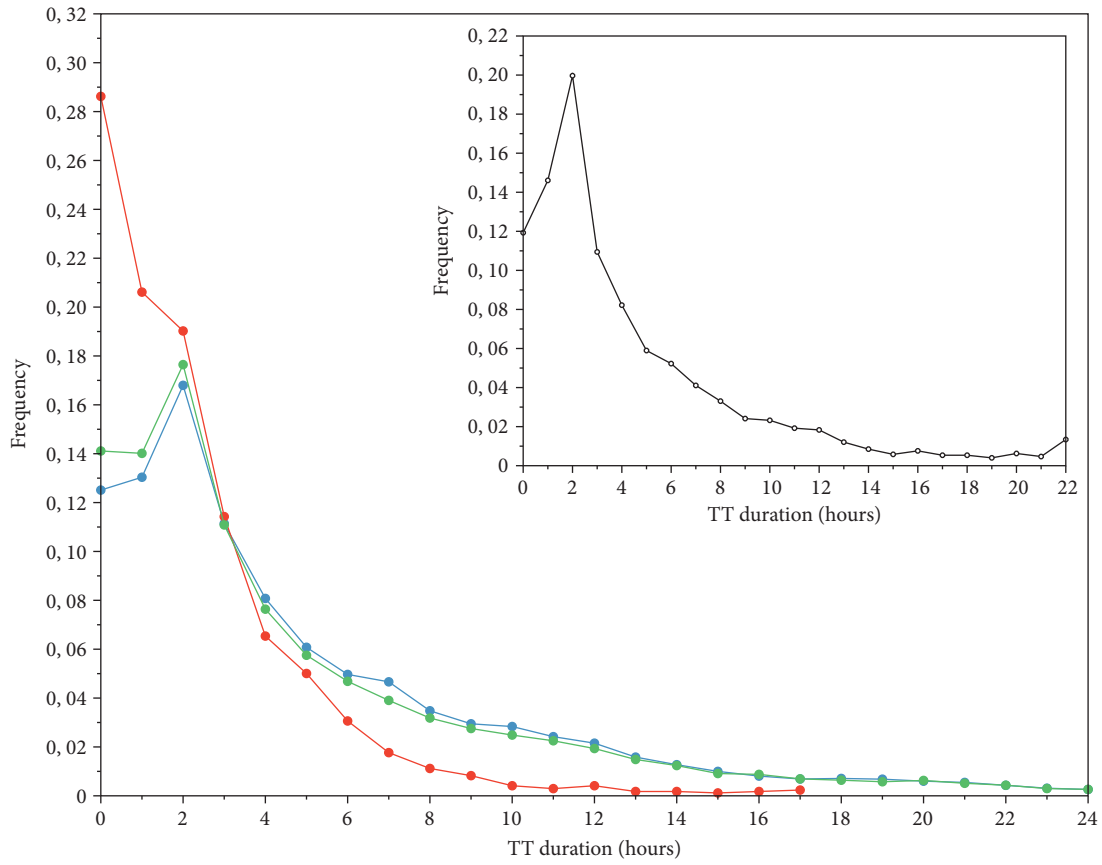


FIGURE 7: Probability distribution of the duration of TT. Blue: before, Red: 3 first days of social outbreak, Green: after. Inset: Probability distribution of the duration of TT in periods of social normality of 3 days, similar in the duration of the first 3 days of the Chilean social outbreak.

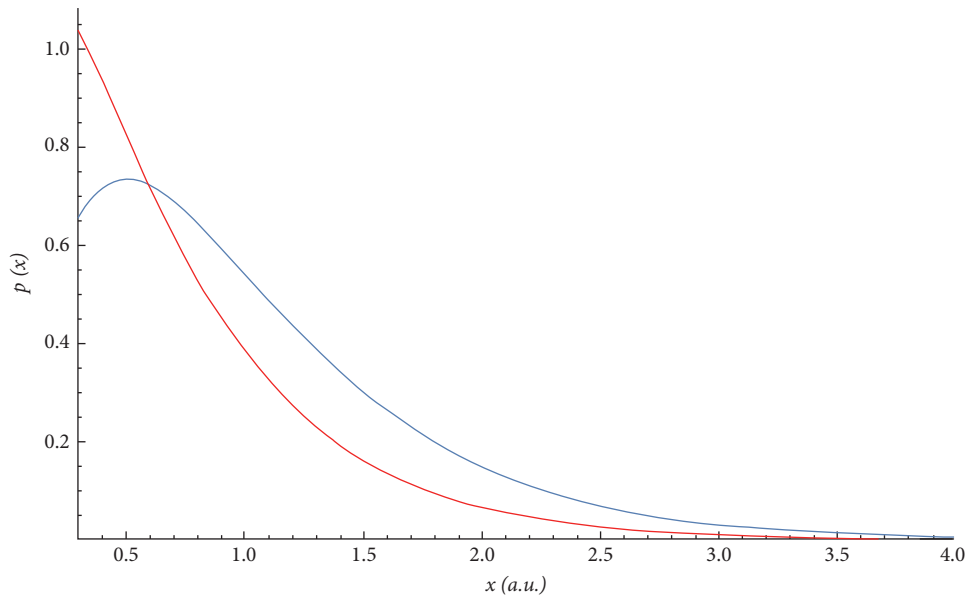


FIGURE 8: Probability distribution of the duration of TT, using the model proposed by equation (2). Blue: $g = 2, e = 3, D = 1.5$ Red: $g = 2, e = 2, D = 1$.

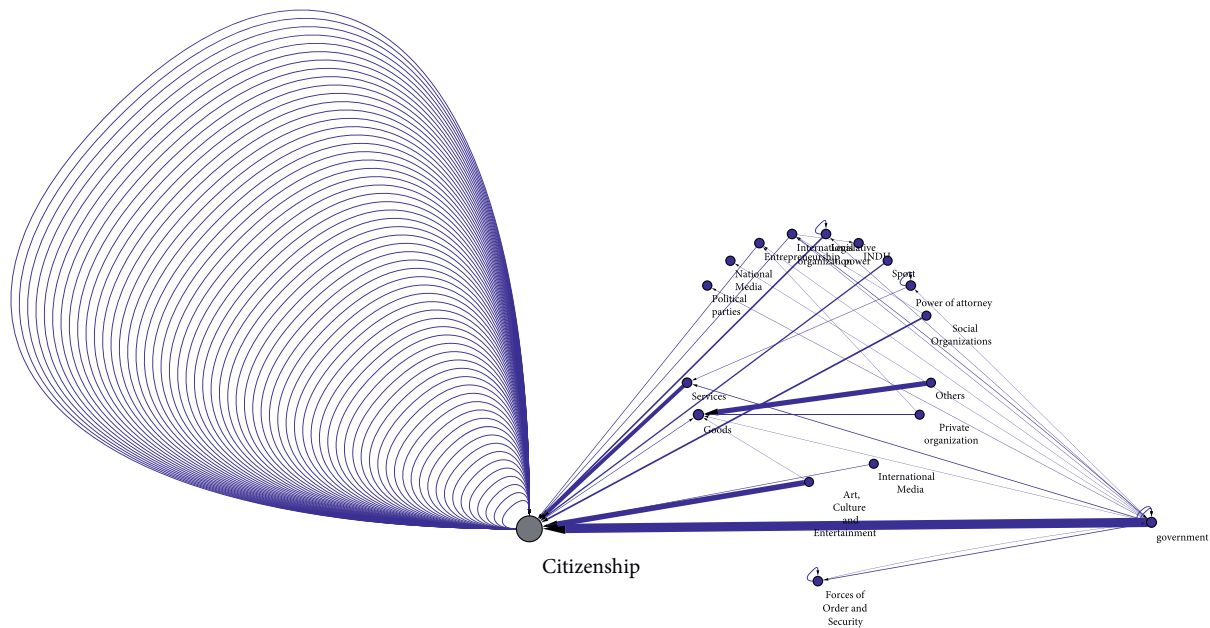


FIGURE 9: Synergistic relationships between actors during the social outbreak.

The network shows a series of synergistic actions from the government to the citizens. The vast majority are short-term events related to the search for consensus in face of social pressure exerted by the latter. Also noteworthy are the social support events (synergistic relationships) between the world of Arts and Culture with citizens. On the other hand, citizens appear as a very active agent in social mobilization events with synergistic, cooperative, and self-supporting relationships (self-links). Finally, the relationship between the agent “Others” and material “Goods” appears frequently, clearly as reparatory actions in the face of the violence of that period.

The conflictive network (Figure 10) shows the other side of the social outburst. At first glance, the density of the links in this network stands out in comparison to the synergistic network, highlighting the conflictive nature of the period. In this sense, the conflictive relationship between the agent “Armed Forces/Forces of Order and Security” and the citizenry stands out. It also highlights the conflictive relationship between government political parties and the citizens during this period evidencing the breakdown of relations between citizens and traditional politics as a sign of the country’s sociopolitical transformation.

The analysis of the dynamics of the relationships described above provides another type of information. Figure 11 shows the entry on the scene of different actors during the social outbreak as well as the generation of relationships between them. We can observe that during the first days of the outbreak (red zone) practically the entire universe of actors participating in this process is configured. However, this analysis highlights the virtually linear increase in the number of relationships between these actors. Although it is true that during the first days of the outbreak almost all the protagonists enter the scene, during this process the network

of relationships between them becomes more complex, generating an intricate network of synergic and conflictive relationships between actors.

3.3. Relationship between Material Activity and Digital Activity. One of the most relevant questions that arise from the analysis of the collected data is which are the relationships between material and digital activity of Chilean society. Our results suggest that Twitter activity at the beginning of the outbreak is reactive. A total of 65% of the events in the days prior to the outbreak had a Twitter match with the TT of the following day. The causality analysis in the days after the beginning of the outburst is extremely imprecise, showing a fluid and dizzying relationship between the material and digital society, making it very difficult to detect causal relationships. However, it is interesting to note that hot topics related to the creation of a new constitution, began to be discussed on Twitter the day after the outbreak started and four days before the first material event referring to the topic. Such digital pressure continued to grow until November 15 with the milestone ASPNC (Figure 12).

Something similar occurs with the pressure exerted by the digital society to constitutionally accuse high-ranking government officials (Figure 13). As in the case of the petition for a new constitution, the digital society began to exert pressure two days before the first material event associated with such accusations.

4. Discussion

In this section, we try to connect the results obtained with the social crisis model (Figure 14) as the result of a process of social adaptation proposed in this study. We understand the (complex) social system as one made up of individuals with

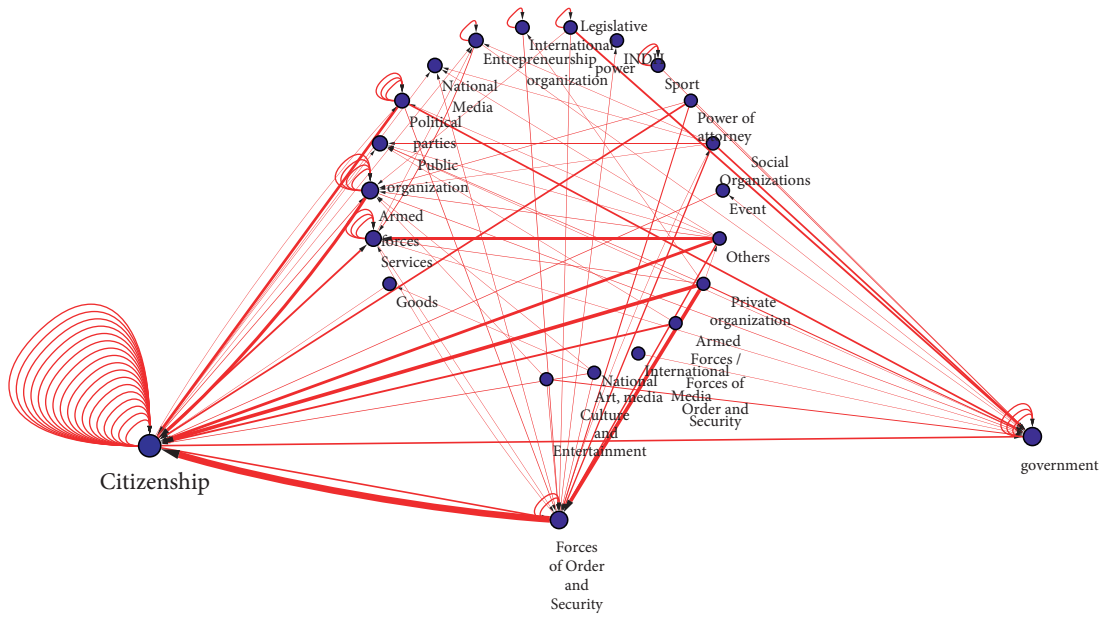


FIGURE 10: Conflictive relationships between actors during the social outbreak.

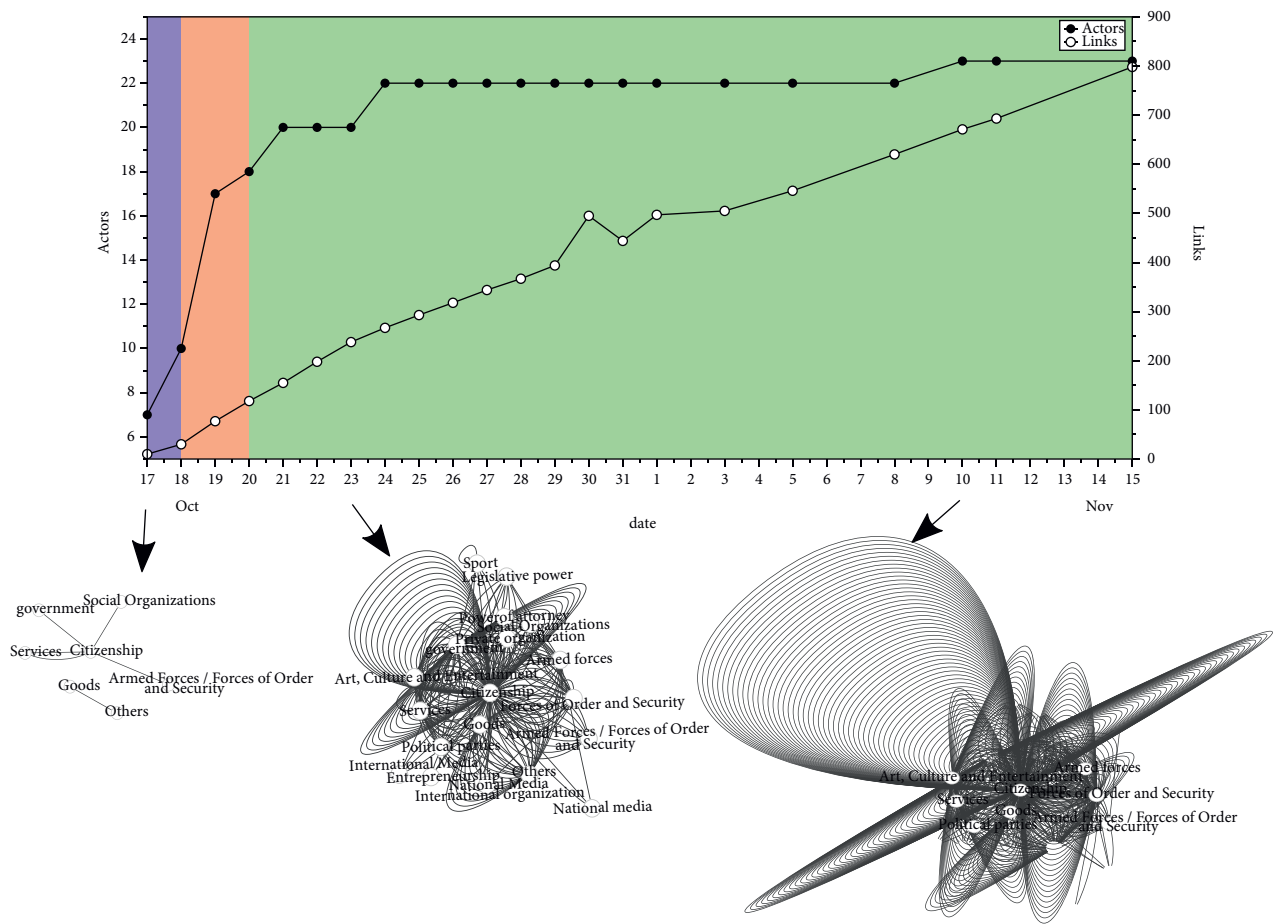


FIGURE 11: Change in complexity of system of actors A(N,R) during the social outbreak.

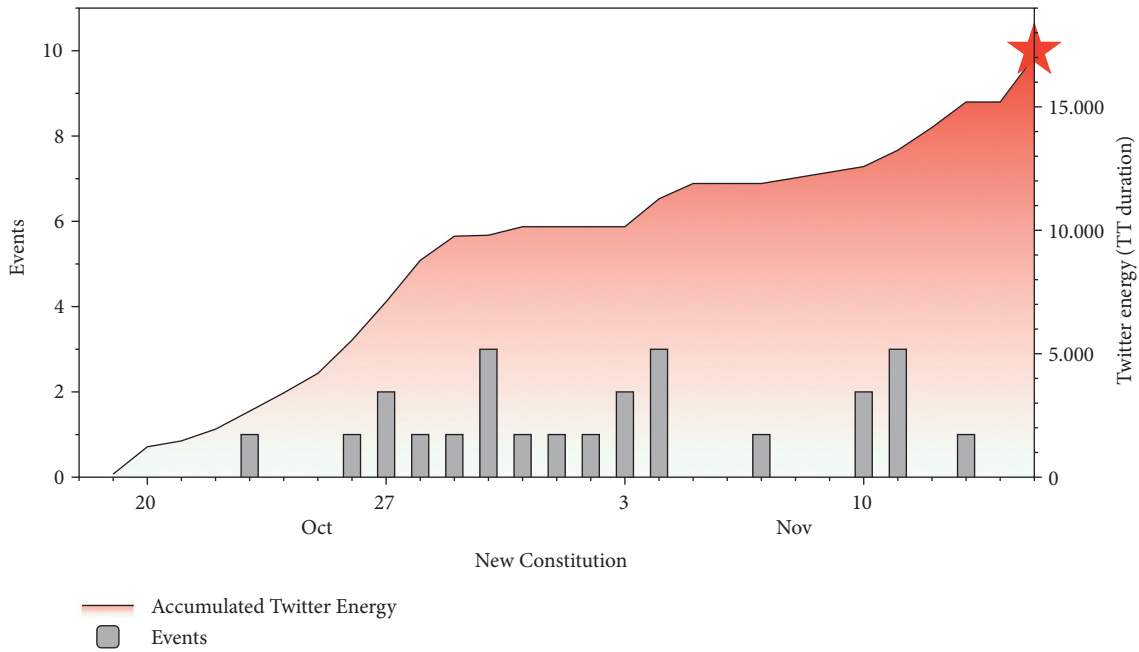


FIGURE 12: Accumulated Twitter energy (TT duration) regarding TTs related to a new Constitution for Chile. Gray bars indicate the number of events of the material society referring to a new constitution. The red star represents the milestone ASPNC.

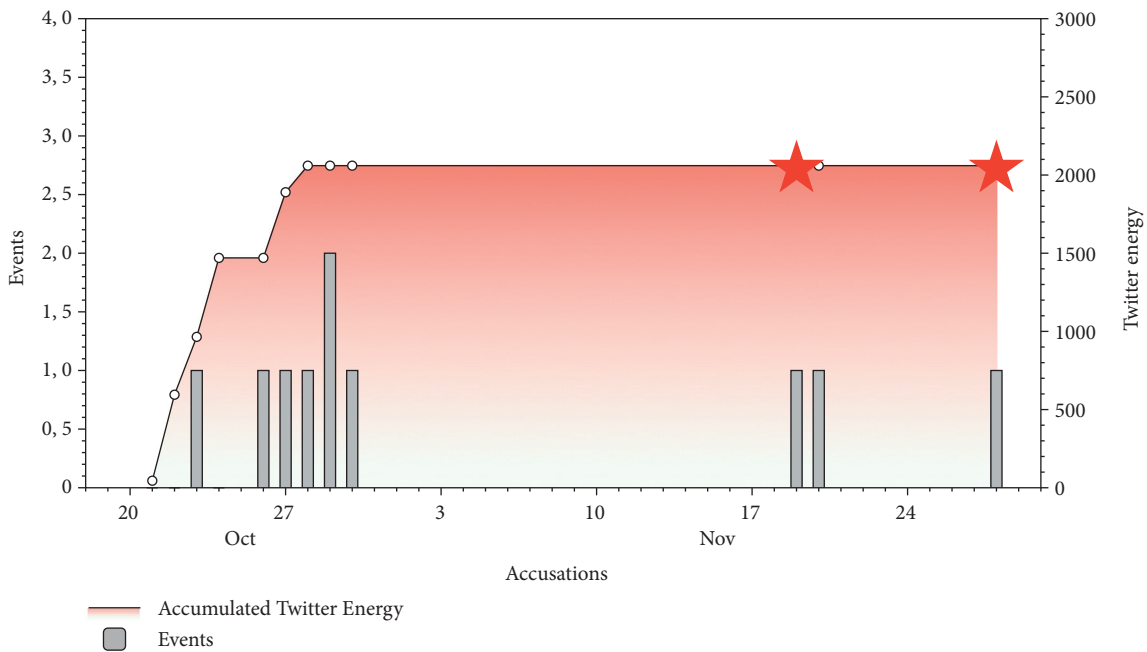


FIGURE 13: Accumulated Twitter energy (TT duration) regarding TTs related to constitutional accusations. Gray bars indicate the number of material society events related to these accusations. The red stars represent events that mark the execution of these accusations.

ideas, thoughts, feelings, and actions that characterize the social group they form and reflected in the constructed social contract. During noncrisis periods (i. e., routine conjuncture [21]), societies are far from a “state of consensus,” in fact, social systems are permanently inhabited by conflicts, struggles, disagreements, cleavage, etc. However, in a state of routine conjuncture, the forms adopted to regulate conflicts operate with some efficiency so that they do not lead to

violence or major social ruptures. It is important to note that the relationship we make between social contract and the state of routine conjuncture is just a simplification for the model.

When adaptive pressures overwhelm regulatory mechanisms, new ideas, thoughts, feelings, and actions, incorporated by the spontaneous increase of complexity of the system, together with other ideas, thoughts, feelings, and

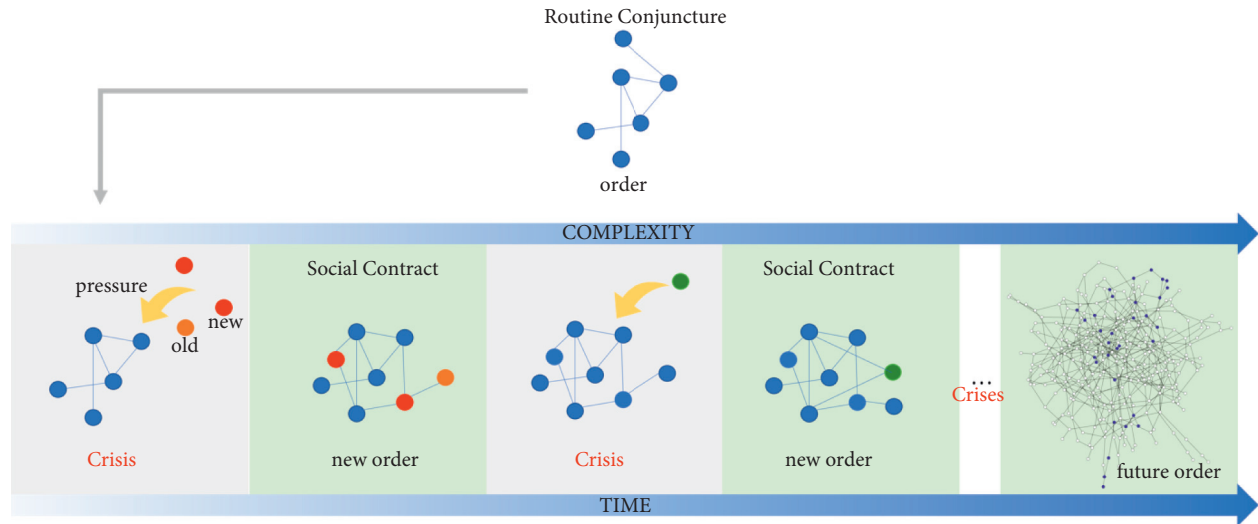


FIGURE 14: Crisis model. A social system can be described from the organization of ideas, thoughts, feelings, and actions of the agents that compose it. From this organization, an order emerges, or social consensus, that defines the way it operates. This order is permanently subjected to adaptation pressures (crisis) that may or may not result in structural changes. This is a continuous process in the evolutionary history of societies.

actions already existing, but now released by those same adaptive pressures, seek a new organizational arrangement. At this moment, the system enters another state, the fluid critical conjuncture [21], or “Crisis,” characterized by the structural plasticity of the system.

The process that begins with a state of routine conjuncture, than a subsequent adaptive pressure that can trigger a structural rearrangement, is continuous in the evolutionary history of the social system. Thus, crises (social) should be understood as natural events, unavoidable and totally necessary for the survival of the system, enriching its models of response to environmental pressures. From this perspective, the phenomenon is part of a deterministic process, although it is governed by the complexity of the system, which makes it impossible to know exactly its result.

In light of the results of this research, we were able to observe what was described in this model. Before the social outburst, the routine situation was characterized by a social behavior, whose reflection in the digital world, accounted for a society interested in topics related to entertainment and sports. On October 18, 2019, a series of events, with “nonspecial” characteristics (controversial behaviors, unfortunate government statements, increase in the price of transport, among others), caused a chain reaction that completely altered the behavior of Chilean society, both in its material and digital manifestations. The “nonspecial” characteristics of the earlier events to the outbreak coincide with [39] regarding the fact that the precursors of massive events are not different from those of minor events when the rules of complexity operate on the system.

The social reaction unleashed that day was characterized during the first days by a thematic explosion and active flow of information that fits with the stochastic growth and decay model of the Lotka–Volterra type (see Sec. Results 3.2). This behavior allowed the emergence of a

new order or organization of ideas and where a series of actors of the outburst began to form a complex network of relationships (Figure 11). It was possible to evidence a process of creative rupture [40, 41] in the behavior of the digital society where social and political issues took prominence over the previously characteristic hot topics that practically disappeared (see Sec. Results 3.1). Despite the fact that the typical behavior of the digital society regarding the probability of distribution of the duration of the hot topics, returned to the way it was before (see Sec. Results 3.2).

The functioning of the digital society did not change in its form, although it did change in the topics it installs. In fact, the outburst made possible the (re)entry of the idea of a new constitution, strongly discussed in 2016 [1], being the digital society, in light of our results, fundamental in repositioning this issue allowing the milestone ASPNC (Figure 10). On November 15, 2019, the Chilean material society found in this agreement a proposal for a “solution” to generate a new social consensus, a new order. This solution was mostly validated by society on October 25, 2020 [42].

We understand this agreement as the result of a self-movement of society toward an organized complexity in the form of a new social contract. Through an emerging process of self-organization, Chilean society captures part of the ideas and abstract language that pressures the social consensus constructed prior to the outbreak. In fact, the environmental issue, of current relevance due to climate change consequences [43, 44], is shared by 38% of the candidates elected to draft the new constitution according to their campaign proposals [45], being the most transversal issue. Other topics that are protagonists of the Chilean crisis such as the recognition of the country as multinational, the defense of water, social rights, decentralization, gender equity, and citizen participation were also incorporated as

force ideas in the programs of the constituents in charge of drafting the new constitution.

5. Conclusions

In this work, we propose a different approach to the phenomenon of social system crises. We understand that these processes can be explained by the adaptive nature of the social system and the associated increase in complexity. However, given the complexity of the social system, this approach requires a quantitative and qualitative analysis of the data associated with the process.

The dynamic nature of the social system generates emergent structures and patterns that in some cases may mean a restructuring of social components, generating a new order. We say that this new order, associated with the incorporation of a growing social complexity, can be translated into a new social contract after a period of profound transformation where previously existing relationships are broken, and new interactions are born. A phenomenon of creative rupture is totally necessary for the survival of the social system. This is what we reveal in the case of the climax of the Chilean social crisis.

On the other hand, the power of language behind the crisis appears in this work. The traditional analysis of online social networks has been focused mainly on the relational structure of its users. However, in this work, we focus on the structure of abstract language relationships behind the crisis. In this sense, it seems that the system of ideas (TIs) hides deep information about the transformation of the social system. It is more than the classic analysis of the number of tweets or the identification of accounts that lead the conversations. In fact, the flow of ideas in cyberspace not only highlights the social transformation but also accounts for the dynamics in the complexity of the social system as well as its ability to guide processes of social transformation.

Our results also seem to validate the model proposed for the crisis processes. The adaptive nature of the social system allows it to explore new organizational structures. In this sense, the rupture of the order prior to the social outbreak, and its replacement by a new emerging one, seems to be materialized in the milestone ASPNC. This social “solution,” as an exploration of the space of possibilities of the social system, is nothing more than that, an exploration that will also have to face adaptation pressures. In fact, since the formation of the Constituent Assembly, it has had to overcome a series of external and internal obstacles. This is a clear sign that the crisis processes constantly affect the system at all scales. The response of this emerging social solution to the pressures of adaptation will tell if its product (i. e., the new constitution) allows the country to exit the critical transformation process it is going through, for an indeterminate time.

Finally, what we can infer from our analysis is a profound relationship between digital and material societies. Although each one has its own logic, our results suggest a nontrivial relationship between the two where, in some cases, one operates as a conditioner on the other. However, and more important than that is the fact that the digital

behavior of society seems to contain relevant information about the processes of social transformation associated with crises. Not only because of the meaning of the symbolic language that circulates on online social networks, but also how it is dynamically articulated and expressed during the process.

A series of questions remain open with this work, for example, we would like to know if what we observe for the Chilean case is also happening in other countries in crisis. Another question is what is the role of the symbolic behind the language of crises. We will try to solve these and other questions in future works.

Data Availability

Publicly available data sets were analyzed in this study. This data can be found at Twitter Public Dataset.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study or with the funding received for this research.

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