

Review

Social Capital on Social Networking Sites: A Social Network Perspective

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Abstract: Although social capital has been researched from many approaches and attempts have been made to measure it online, the literature lacks an operational description that would allow its measurement criteria to be established from a social network perspective. Therefore, the purpose of this paper is to identify in the literature what metrics researchers use to measure social capital on social networking sites from a social network perspective. Thus, this contribution offers a theoretical description of the key elements for measuring social capital in social networking sites, which may be useful in subsequent studies.

Keywords: social capital; social network; social networking site; social capital measurement; literature review



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1. Introduction

The growing trend among national and international companies to introduce sustainability criteria in the management of their operations is advancing in parallel with social criticism of negative impacts on the environment and society, especially since the 1990s [1]. Consequently, large companies are reporting their responsible actions both to enhance their reputation and positively influence their stakeholders [2,3], and to gain active participation and commitment to their sustainable development [4].

SNSs have become a channel for disseminating corporate information to all types of stakeholder audiences. There is evidence that the communication of responsible actions of companies, in these networks, increases their possibilities of establishing new links (i.e., with their customers), contributing to the welfare of society and the generation of social capital [5]. Since the last decade, these contributions have been evaluated not only for their direct environmental impacts but also in terms of the social dimension of sustainability reflecting the relationships, support, and influence that companies have within their social networks [6].

The social dimension of sustainability refers to the ability to maintain society in a certain state that is affected by the social structure, interaction, norms, values, and shared language that contribute to social well-being [7–9]. Different factors have been suggested to describe the social implications of sustainability, among them one of the most important is social capital (i.e., [10,11]), which is the focus of this study as a non-physical contributing factor of social sustainability.

In the scientific literature, social capital has become increasingly important in the discourse on ties for building and social interaction on social networking sites (SNS). There is evidence that creating and strengthening ties in a social network generates identifiable social capital and that this capital contributes to economic growth and development based on the construction of mutually satisfactory relationships [12–14].

A commonly identified weakness in research on social capital in the SNS is its measurement [15–17]. Firstly, there is a lack of coherence between the multiple theoretical definitions of social capital and in specifying its main components. Secondly, there is no operational description of the key elements for assessing social capital with data from the SNS and no agreed set of indicators [18].

To solve this, a literature review was conducted focused on identifying the indicators and metrics currently used to measure social capital in SNS platforms from a network perspective. The search for these three concepts generated a total of 78 documents extracted from the Web of Science (WoS) database, of which, after applying the criteria explained in the methodology section, 42 been processed and analyzed from a bibliographic and literature content approach. The content analysis has focused exclusively on identifying and examining how the selected articles measured social capital approaches, including the network analysis indicators, methods, and data from the different SNSs they used. Thus, as the objects of study of these studies are heterogeneous and in most cases, the measurement of social capital is an instrumental aspect, this paper has dispensed with their analysis to focus on how they have measured social capital in SNSs.

The results of this study can help academics to optimize the selection of appropriate frameworks for their empirical studies, and to equip professionals with a tool for analyzing their efforts to build social capital in their SNS. It also contributes to the understanding of the factors that influence the sustainable development and empowerment of individuals and communities.

This document is structured in the following way: in Section 2, the adopted definition of social capital and its constituent approaches and characteristics are presented, together with the environment or infrastructure where it has been analyzed as a source of information, and also its relationship with social networks. Section 3 details the methodology of the study, the criteria adopted, and the general procedure that has been followed to fulfill the purpose. Section 4 develops the analysis and interpretation of the study's findings and the discussion where the definition, characterization, operationalization, and measurement of social capital are connected. Finally, in Section 5, some conclusions about the analyzed research are provided.

2. Theoretical Background

2.1. Social Dimension of Sustainability

Sustainability is a widely used term with a wide range of definitions and has become a multi-focal agenda. Since 1987, it has been interpreted as a continuous process of development in which environmental, economic, ethical, and social considerations are integrated to meet the needs of a community. These dimensions are conceived as separate and independently connected. Although there is a constant flow of resources between them, their boundaries are diffuse, especially those of the social dimension. This is perhaps because its impact is easily identifiable as the dimension that affects the other dimensions of sustainability, but it is not easily measurable [10,19–22].

In the 1990s, this dimension had been neglected, playing a minor role in sustainability discussions compared to the other dimensions. However, in the last decades, it has been considered as a fundamental aspect within the sustainability agenda even though its notion remains under-theorized, with some lack of connection to the other dimensions and difficulties in recording it empirically [20,23–25].

The social dimension of sustainability is a process for the creation, consolidation, and maintenance of a prosperous society that provides for common well-being and needs. On the one hand, it is determined by physical (i.e., social infrastructure) and non-physical (i.e., social capital) factors [11]. On the other hand, it is affected by the social structure, its characteristics, and what happens within it in terms of norms, values, and interactions.

Social capital describes, systematically, social interaction and social networks, conceiving them as integral aspects. Hence, some authors associate social capital as a component of sustainability, among others, that contribute to the satisfaction of needs that change

regularly in a society [9,10,26,27]. Therefore, this study focuses on breaking down the concept of social capital to the point of presenting a measurement framework of its different dimensions based on the indicators of the network perspective: specifically, when resource transfer and ties occur in SNS platforms.

2.2. Social Capital

Social capital has been studied in different fields of social, economic, and political science [28], creating a large number of definitions and representations of its characteristics. Various researchers, from Hanifan [29] to Adler and Kwon [18], have distinguished social capital according to context, forms, possible uses, and interaction groups [7,18,30–36]; however, the concept that has been most widely accepted and applied is that proposed by Bourdieu [37]:

“Social capital is the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition, which provides each of its members with the backing of the collectively-owned capital, a “credential” which entitles them to credit, in the various senses of the word”.

The social capital available to members of a group is integrated into their social networks and represents an investment in relationships for future profit [7,14]. Membership, network connections, and close interaction provide access to these resources, allowing them to improve their quantity, quality, depth, and efficiency of exchange by promoting the consecutive development of an individual or a community [17].

In short, beyond the information or resources directly held by one member, the importance of social capital lies in the set of resources—economic, cultural, or symbolic—of other members that can be mobilized thanks to their relationships and connections [38–40]. The social capital available depends on the social context, the position that each member has in the network, its connections, and the level of access.

2.3. Categorizing Social Capital from Two Approaches

Two main points of view are identified in the study of social capital: one is centered on the social structure represented in the ties inherent in the relations [7,33,41], and the other is based on the typology of the resources mobilized in the relations of material or symbolic exchange [30,32,34,42].

The first approach, strongly influenced by network theory, analyzes the nature of social capital from the type of ties between its sources and highlights the theory of the strength of weak ties [43,44] and Burt’s structural holes [45]. The second approach analyzes the nature of social capital from its effects as proposed by Nahapiet and Ghoshal [32], Tsai and Ghoshal [36], among others. Thus, these two approaches enable social capital to be categorized according to the type of ties and the type of resources (Table 1).

2.3.1. Ties Type Approach

The connections that the members of a network establish with each other are the infrastructure through which social capital flows. These relationships vary in their degree of formality, closeness, strength, or other criteria, which make it possible to classify a great variety of relationships into different types of ties. The types of ties most addressed by researchers enable the classification of social capital into bonding and bridging [34,46,47].

Table 1. Framework of the definition and characterization of social capital (own elaboration) *.

Topic	Approach	Categories	Description Categories
Social Capital: “The sum of resources, actual or potential, that correspond to an individual through the possession of a lasting social network based on good relationships” [37]	Type of ties	Bonding Form	Strong ties Redundant range Dependent interactions Exclusive relationships—favors trust and social support Dense and cohesive network structures No lack of ties
		Bridging Form	Weak ties Non-redundant Mobilizing new information Suitable for dissemination Facilitate greater exchange Large social structures Absence of ties
	Resources	Structural Dimension	Network configuration and position
		Cognitive Dimension	Shared values and interests
		Relational Dimension	Social relationship behaviors

* Approach, categories and description are supported by [32,34,43,48].

Both typologies depend on the characteristics of the ties that mobilize the resources embedded in a network and the opportunities to access them [49]. This approach is adopted in this paper for the analysis and classification of the measurement elements used in the literature reviewed.

- *Bonding* social capital is derived from the relationships between members of the same group. These closer and more frequent relationships result in higher levels of trust, support, and intimacy. They are called strong bonds, and they are the consequence of exclusive relationships associated with dense and cohesive network structures [18,34].
- *Bridging* social capital flows through the weak ties that connect network members to external elements [18]. They are considered weak ties because they connect individuals not belonging to the focus group with which a similar context or emotional reciprocity is not shared [43,45,50].

First of all, this approach reveals the uniting force of social relations which, measured by the combination of time, intensity, intimacy, and reciprocal services, characterize the ties [43]. Secondly, it addresses network structures and their implications on the flow of mobilized resources [51], into which Burt [48] goes deeper by analyzing the positions of different members in the network, the gaps between them, and the presence of key members who may be an asset in themselves due to their bridging position.

Putnam [34] suggests considering both high and low proximity or strength ties equally. Strong ties (close proximity) support reciprocity and solidarity, creating trust within the group and improving the internal transfer of resources [44,52]. Weak ties are presented as the most suitable for diffusion while providing effective social cohesion and thereby avoiding disconnection between different groups [43]. For this reason, it is often pointed out that bridging social capital provides greater advantages than bonding.

Structurally, on the one hand, some members share a similar context by forming a group connected to others, trusting and supporting each other, and exchanging resources [48], often identified by their network density [53]. These closed, tightly knit structures lock assets into sub-optimal and redundant exchanges, thus creating social capital [54]. When closed, these structures limit access to inherited resources through social relations within the group. However, they facilitate compliance with rules that promote trust among network members, protecting the reputation of well-behaved members [7,53].

On the other hand, in a social structure, it is possible to find groups that are largely unconnected with each other and separated by a hole in the social structure. The bridging ties

that cross these holes can provide capital by offering opportunities to connect and broker the flow of novel resources, which are what Burt [45] refers to as structural holes. He considers that these structures with structural holes (large, less dense, and non-hierarchical networks) result in a richer and more diverse network [48,55], thanks to the intermediaries or members who establish the tie through the hole. These members prevent the network from collapsing into small groups and help to connect non-redundant sources of resources.

In summary, from the ties-type approach, social capital is characterized by addressing ties in terms of competitive advantages that are derived from how resources embedded in the network are obtained. This is analyzed on the basis of notions of tie strength and social structure in order to determine the ties that tend to connect members according to the flow or transfer of resources [12,14].

2.3.2. Resource Approach

The nature of social capital arises from the resources that are mobilized among the members of a network. According to the theory of social capital, these resources or assets generate profits that facilitate the creation of value [32,36,56]. Their source lies in the structure and content of the relationships between the members of a network, and their effects derive from the intensity of information exchange, influence, and solidarity that are made available [18].

This approach identifies different ways of representing the various resources that are owned, acquired, or mobilized in a social network. The proposal by Nahapiet and Ghoshal [32], which is widely accepted, considers three interrelated dimensions: structural, cognitive, and relational, which are adopted in this work analysis and classification of the literature reviewed.

- The *Structural* dimension refers to the patterns of connection between the members of a social network, described in terms of network configuration and position, the distance between resources, accessibility in terms of hierarchy, connections, and variety or heterogeneity of the structure, and therefore supported by social network analysis (SNA). Thus, the type of network structure influences the capacity of access and exchange of resources between members [45].
- The *Cognitive* dimension refers to the resources that facilitate communication, dissemination, and social cohesion. These are the values, interests, paradigms, and interpretations shared among the members of a network. This dimension has often been analyzed through shared narratives, codes, and language. These resources contribute to a better mutual understanding, facilitate the comprehension of collective objectives, and improve the capacity for exchange and sharing [7,57].
- The *Relational* dimension represents both the resources embedded in the network and those originating from interactions [14]. This dimension provides a solid basis for transfer and exchange, for preventing opportunistic actions, for motivating cooperation, and for maintaining close and frequent interaction [30,36].

Both the structural and the relational dimensions are considered a stock resource, since the accumulation of both direct and indirect relationships is because of the flows of relationships established and maintained over time. In the case of the structural dimension, the stock increases, i.e., to the extent that the members of a network are able to fill empty spaces by intermediating between disconnected members. In the relational dimension, trust, reputation, loyalty, cooperation, etc., are facets that feed back on each other. On the other hand, Dierickx and Cool [58] consider the cognitive dimension as a non-accumulative resource, which is referred to as systemic, deriving from beliefs, values, interests, etc. and consisting of assets that are more visible, easily identifiable, and imitable [58–61].

As a summary, Table 1 presents the concept and categorization of social capital that has been adopted for the development of this study.

2.4. SNS as a Social Capital infrastructure

SNSs are online services that allow users to participate in a network of connections with which they share information, news, status updates, comments, photos, or other forms of content [62]. These services offer each user three main components: a public or semi-public profile, a flow of content with which they can interact or consume, and a set of ties to other users [63]. These components enable different social structures to be recreated within the system, as well as determining the social interactions present during the exchange of resources in the network [64]. According to Blau [65], such interactions can be assessed by comparing the resources invested (i.e., behavior, the intensity of use, frequency of online participation) with the resources and benefits acquired (i.e., friendship, support, loyalty, reputation, etc.).

While research on SNS has focused on understanding identity building, the nature of ties, community structure, benefits of participation, etc. [66,67], there is also a marked interest in analyzing social interactions in SNS platforms as a source of social capital [68]. Communication opportunities in the SNS enable users to identify common points with others, thus deepening relationships and facilitating access to sources of resources (i.e., social support). Furthermore, they facilitate communications between individuals belonging to different social action groups, which allows for a larger network of diverse ties through which innovative resources can flow [13,69]. In other words, SNSs enable both strong and weak ties [70], and the use of SNSs promotes benefits derived from participation, interaction, and dissemination, which are conceptualized as resources generating social capital [62,69,71,72].

2.5. Measuring Social Capital in SNS Platforms

The multidimensional nature of social capital, as well as its diversity in terms of interaction, profit generation, etc., have contributed to the fact that a remarkable variety of forms of measurement can be found in the literature [30,40]. Although there has been much discussion about how social capital should be measured by presenting different metrics for such measurement, no generalized form is known for measuring its characteristics in SNS from a network perspective [73–75].

Granovetter [43], Freeman [76], and Lin et al. [60] are pioneers in the adoption of the network perspective, as well as Bourdieu [37], who indicates that both the size of the network and the quality of the members characterize the social capital [74]. Later, Coleman, Krackhardt, Portes [7,44,77], and Burt [7,45,54], among others, considered the configuration and position in the network for studying tie strength and structure as key elements of social capital sources. Access to and use of social resources would be determined by the size, centrality, density, heterogeneity, and other hierarchical characteristics of the network from a structural point of view [38].

The SNS incorporate the same particularities of a social network structure: they are virtual spaces in which resources are created and shared, thereby contributing to collective action, promoting ties and social interactions between members. As individuals spend more time in the SNS, academics are increasingly interested in understanding the effects of these actions and benefits on the platforms that generate social capital [78]. Thus, the SNS offer access to social capital by providing those who are well connected with the resources to maximize their relationship capital [79]. In this context, the measurement of social capital has taken into account elements of their approaches regarding the characteristics of identification of the individual with the community in which he or she participates, i.e., social identity, trust, influence, and cooperation, among others [75,80–82].

There are two groups; on the one hand, some researchers have constructed scales for measuring social capital in SNS (i.e., Putnam's instrument, Grootaert and Bastelaer's SOCAT tool [83], D. Williams' ISCS [75], Chen et al.'s SCIS [84], among others) by evaluating the results as social capital rather than the network itself [75]. These scales have been used in a large number of investigations using surveys or questionnaires as data collection instruments. In a way, they choose variables of analysis with indirect indicators (somewhat

distant from the possible reality) without outlining a network to describe the strength of the ties and their structural sets [85].

On the other hand, a smaller group of researchers have used the SNA to measure social capital with network properties depicted with the SNS information obtained either from simple descriptive measures, i.e., the number of friends, the number of comments, etc. [86,87], or from formal mathematical models that link specific structural characteristics. These investigations have yielded a range of possibilities, which Bodin et al. [88] grouped into three broad network approaches. The first, a metaphorical approach, refers to the group of investigations that have determined whether or not there is information exchange. The second, a descriptive approach, refers to the group of researchers who have described the key characteristics of social networks with simple measures. Lastly, a structurally explicit approach covers studies that have used systematic methods for data collection.

Several indicators have been used to measure social capital on SNS platforms. However, there is disagreement about which network properties correlate with their performance, and no consistency exists in terms of the operationalization of the different characteristics of social capital [89,90]. Therefore, in the area of study, it was considered pertinent to review the existing literature to determine how research on social capital in the SNS presents the characteristics and how it has been measured.

3. Review Methodology

In order to answer the research question, this work adopted a structured process of collecting and categorizing the literature, which consists of three main stages [91]:

Stage 1. Selection and collection of literature. This stage describes the search process and details the qualitative process for filtering documents. The Web of Science (WoS) Core Collection database has mainly been used as a search tool to identify relevant research, as it is considered relevant in the field of communication technologies and social sciences [92]. Furthermore, for the filtering of the articles, it was decided to work with research: (1) published in indexed, full text, peer-reviewed journals, with available references and linked to the WoS database; (2) without time limitation to cover all the literature available on the subject; (3) published in English; and (4) of the “article” and “review” type; excluding specific types of publications such as short communications and commentaries, editorial notes, symposia, congresses, and book reviews.

The search process began by tracking articles containing the terms “social capital”, “social networking sites”, and “social networking theory” in their titles, abstracts, and keywords. The use of the general concepts as search terms resulted in a large number of hits in various journals. It is important to note that in this process, several queries were made by combining the input terms and using different operators of Boolean logic on the fields. A preliminary review first showed that “social capital” was analyzed according to its different dimensions (i.e., structural, cognitive, relational). Secondly, “social networking sites” were often associated with “online social network”, “social networking service”, and “social media site”. Thirdly, “social network theory” was related to “social network analysis”. Since these terms are synonymous, commonly found, and provide information relevant to the area of study, it was decided to include them as additional search terms. Furthermore, it was decided to include some of their acronyms referenced in the literature (i.e., “OSN”, “SNS”, “SNA”).

A subsequent review first found that it was appropriate to relate “social capital” to the particular characteristics of each dimension (i.e., participation, cooperation, influence, etc.). Secondly, some of the “SNS” platforms (i.e., Facebook) should be specified. Thirdly, it is relevant to reference the attributes that particularize social networks from a theoretical point of view (i.e., centrality, ego, etc.).

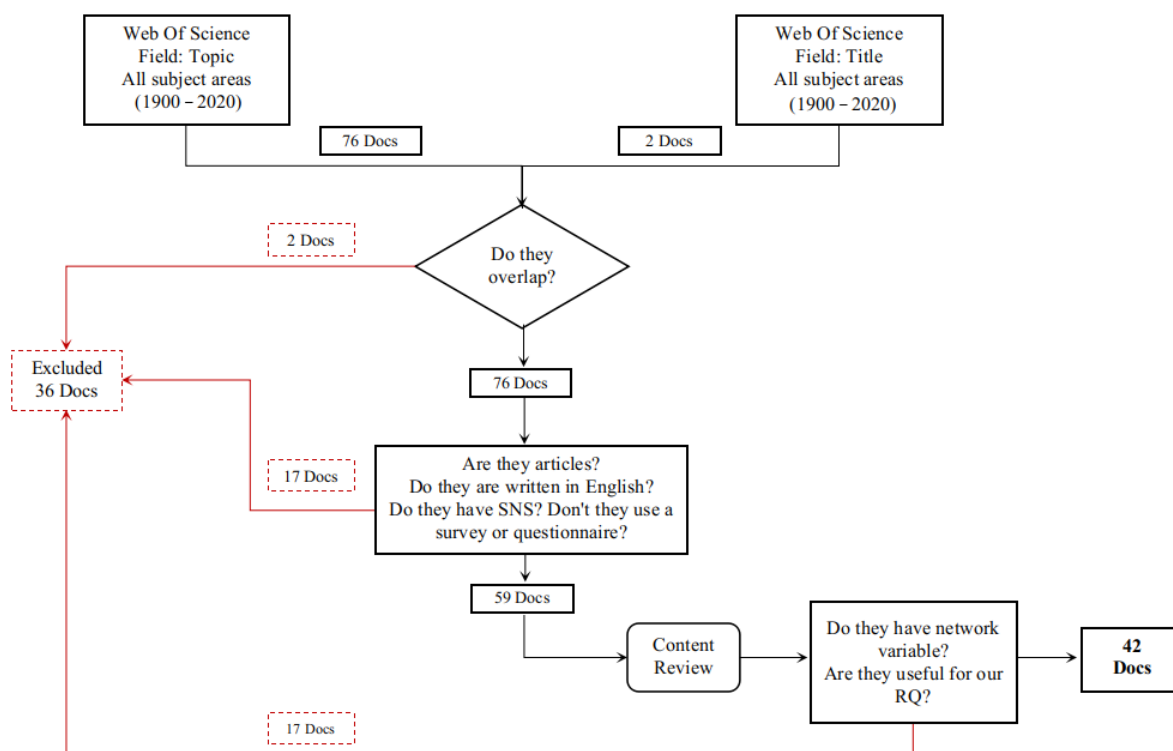
Given the purpose of this review, the terms were refined through multiple iterations of key words until arriving at the final search equation (see Table 2). The search generated 76 articles. These were obtained from documents published between 2009 and March 2020 (when the data collection procedure was closed).

Table 2. Keywords and final equation used on the WoS database (own elaboration).

Extended Search Terms	
Issue of Interest	Social capital, cognitive social capital, relational social capital, structural social capital
Medium/Infrastructure	Social networking sites, online social network, social networking service, SNS, OSN, social media site, Facebook, Twitter, Instagram
Perspective	Social network theory, social network analysis, SNA, centrality, density, degree, network size, betweenness, closeness, ego network
Search Equation in WoS	
TS = ("social capital" OR "social engagement*" OR "social cooperation*" OR "social reciprocity*" OR "social trust*" OR "social contagion*" OR "social identity*" OR "social prestige" OR "social cohesion" OR "cohesiveness" OR "social influence*")	
AND ("social networking sites*" OR "online social network*" OR "Social networking service" OR "social media site" OR "SNS" OR "OSN" OR "twitter" OR "Facebook" OR "Instagram" OR "YouTube" OR "LinkedIn")	
AND ("social network analysis*" OR "social network theory" OR "SNA" OR "network size*" OR "network density" OR "degree centrality" OR "embeddedness" OR "betweenness" OR "closeness centrality" OR "ego network*" OR "structural hole*")	

Note: WoS (n = 76 Art. Without settings)–(n = 76 Art. With date, type, language criteria). (*), it is a wildcard in the WoS searches' syntax.

Upon reviewing these documents, it was concluded that some of the articles corresponding to the selected terms were not relevant to answer the research question. Therefore, it was decided to work with exclusion criteria that would allow the selection of only those articles that were really relevant [93]. Thus, 17 articles were excluded: (a) those that did not work with at least one SNS; and (b) those that used interviews, questionnaires, and/or surveys as the only data collection method. This is because we want to identify variables that were analyzed and evaluated with SNS metrics. From this procedure, a list of 59 articles was obtained, as presented in Figure 1.

**Figure 1.** Steps for selecting relevant studies in literature (own elaboration (The structure was followed as proposed by [94])).

Stage 2. Information processing. To determine whether the selected articles were really focused on the field of study, their information was collected in an Excel file. On the one hand, their bibliographical information (i.e., title, authors, year of publication, affiliation of the first author with the country, journal, abstract, keywords, number of citations) was extracted as initial input. On the other hand, after a more complete reading, content information was extracted, which contrasts the conceptualization and operationalization used in the articles reviewed; i.e., subject matter, variables, level of network analysis, context, methods used, etc. [95]. From this process, 17 articles were excluded because they had no network ownership and because, although they sometimes mentioned the term “social capital”, “SNS”, or some concept referring to these, they focused on other topics outside the scope of the research question. In total, the final database consists of 42 articles in full text format published between 2009 and 2020 (Figure 1).

Stage 3. Analysis of the information. This stage was structured in two steps [96–98]. First, the classification and analysis of the bibliographic information enabling an explicit summary of what is known [99] about social capital research in SNS based on the network perspective. There are different ways to carry out this step. In this study, it was conducted by using bibliometric indicators and methodological characteristics in order to know the trends in the evolution, productivity, relevance, and interest of the field of study in the academic and professional context. In addition, it can provide a summary of the methodological approach, main topics, SNSs used, among other relevant information of the articles reviewed.

Secondly, the descriptive–qualitative analysis of the content information allows the identification of patterns in the variables that the researchers have correlated with the measurable characteristics of social capital in the SNS based on SNA. To this end, a process of disaggregation of the concept is followed, taking it to the most concrete level possible, which will be extensively explained in Section 4.2.

4. Outcome Analysis and Discussion

4.1. Analysis of Bibliographic Information

4.1.1. Evolution of Publications and Leading Journals

Figure 2 shows the evolution of the 42 articles selected for the study and their corresponding journals, of which 67% (28 articles) were published in 2016 and subsequent years. It is equivalent to two times the number of articles published between 2011 and 2015. It highlights the following: (1) the trend of linear growth in the number of articles published in the field of study, which implies that academic interest in the subject is relatively recent; (2) since the attention devoted to research in the field of study has increased, the number of journals interested in publishing on the subject has also increased. Thus, 13 different journals published articles during the first five years (2011–15) and 22 different ones during the following years (2016–19); (3) the majority of publications were in journals with an impact factor (IF); (4) these trends, taken in moderation, give an indication of the possible recognition or growing legitimacy of the field of study as a viable research topic.

4.1.2. Citation Structure and Authors in Research

As an indicator of the productivity and impact of the authors' publications, the citations received for articles published in the field of study were reviewed [100,101]. As can be seen in Table 3, the article by Aral and Walker [102] has the highest number of citations (116) and the highest average number of citations per year (16.57), thus constituting the most influential article to date. This article analyzes network indicators (i.e., embedding and tie strength) as moderators of a characteristic of social capital (i.e., social influence) in the adoption of a product. The analysis of these authors shows that heterogeneity in relationships affects the influence that an individual has over others, and that social or structural conditions exist under which the influence becomes stronger [102].

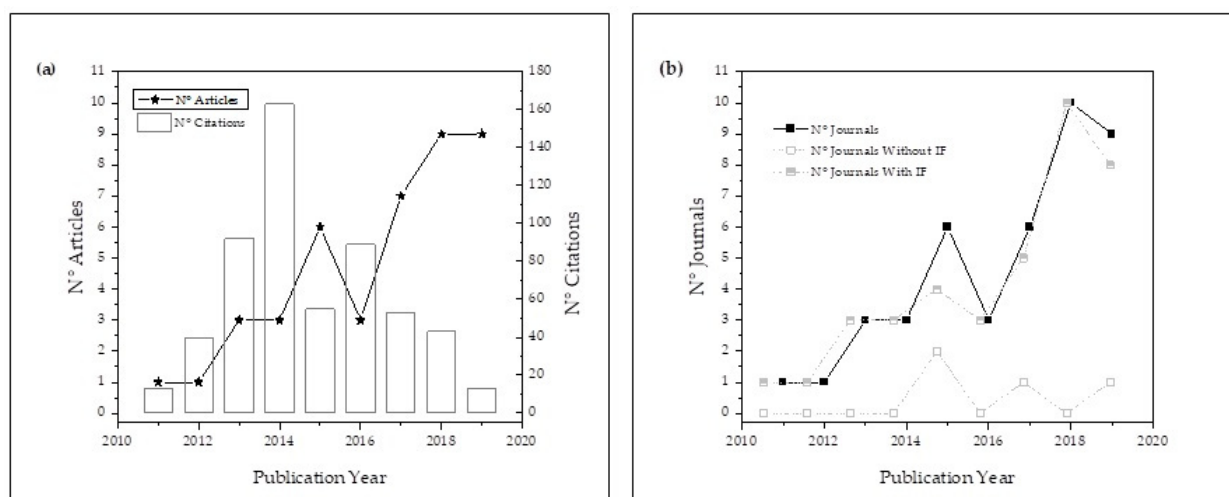


Figure 2. Evolution of research on social capital in SNS: (a) Characteristics of publications; (b) Characteristics of journals (own elaboration).

Table 3. Top 10 authors in the area of study (own elaboration).

Author	N° Articles	Citation ¹	Citation/Article	h-Index ²
Aral, Sinan	1	116 (16.57)	116.0	4 (19)
Walker, Dylan	1	116 (16.57)	116.0	4 (5)
Riquelme, Fabian	1	66 (13.2)	66.0	1 (4)
Gonzalez-Cantergiani, Pablo	1	66 (13.2)	66.0	1 (2)
Carlisle, Juliet E.	1	63 (7.88)	63.0	1 (10)
Patton, Robert C.	1	63 (7.88)	63.0	1 (13)
Brooks, Brandon	2	49 (6.44)	24.5	2 (12)
Hogan, Bernie	2	49 (6.44)	24.5	2 (11)
Rehm, Martin	2	22 (4.80)	11.0	2 (4)
Garcia, David	2	17 (4.08)	8.5	3 (15)

¹ Citation information refers to the total number of citations received in the author's publications on social capital in SNS. The data in parentheses indicate the number of average citations per year; ² The field-specific author's h-Index has been consulted from the WoS database. The information in parentheses indicates the global author's h-Index consulted from the WoS database.

4.1.3. Methodological Characteristics Analysis

Table 4 and Figure 3 provide an overview of selected articles that have been published in the field of study. It identifies, first of all, that the journal with the largest number of articles published between 2011 and 2019 is *Social Networks* (4). The literature found in this journal focused mainly on the social capital aspect of the types of ties or connections within an online social network, with each article working in a different SNS. This journal is followed by *Computers In Human Behavior* (2), *Information Communication & Society* (2), *International Journal of Human–Computer Interaction* (2), and *Social Science Computer Review* (2). It should be noted that the 42 selected articles are disaggregated into 35 different journals, which indicates a high dispersion and lack of maturity in the field of study [103].

Table 4. Methodological characteristics of the selected articles (own elaboration).

Author(s)	Journal	Design and Method ¹				Collection ²	
		T	L	Ex	CS	D	M
[102]	Management Science		X	X		X	
[104]	Addiction Research & Theory		X	X		X	
[105]	Social Science & Medicine		X	X			X
[106]	Information, Communication & Society	X		X		X	
[107]	Social Networks		X	X			X
[108]	Political Research Quarterly		X	X			X
[109]	Industrial Management & Data Systems		X	X		X	
[110]	Concurrency and computation-practice & experience		X		X	X	
[111]	IEEE ACCESS	X		X		X	
[112]	City & Community		X	X		X	
[113]	Computers in Human Behavior		X	X		X	
[114]	Computational and Mathematical Organization Theory		X	X		X	
[115]	Policy & Internet		X	X		X	
[116]	Computers in Human Behavior	X		X		X	
[117]	MIS Quarterly		X	X		X	
[118]	The Internet and Higher Education		X	X		X	
[51]	Journal of the Association for Information Science and Technology		X	X			X
[119]	International Journal of Human–Computer Interaction	X		X			X
[120]	Youth & Society		X	X			X
[121]	Information, Communication & Society		X	X		X	
[122]	Scientific Reports		X	X		X	
[123]	Data Min Knowl Disc		X	X		X	
[124]	ACM Transactions on Computer-Human Interaction		X	X			X
[89]	Social Networks		X	X		X	
[125]	Social Science Computer Review		X	X		X	
[126]	Internet Research		X	X		X	
[127]	PLOS One		X	X		X	
[90]	Social Networks	X		X		X	
[128]	Social Cognitive and Affective Neuroscience	X		X			X
[129]	Social Media + Society		X	X		X	
[130]	Teaching and Teacher Education		X	X		X	
[131]	Interactive Learning Environments		X	X		X	
[132]	International Journal of Human-Computer Interaction		X	X			X
[133]	Information Processing and Management		X		X	X	
[134]	Social Network Analysis and Mining		X	X		X	
[135]	American Behavioral Scientist		X	X		X	
[136]	Journal of Universal Computer Science		X	X		X	
[137]	Social Networks		X	X		X	

Table 4. Cont.

Author(s)	Journal	Design and Method ¹				Collection ²	
		T	L	Ex	CS	D	M
[138]	Frontiers in Physics		X	X		X	
[139]	Social Science Computer Review		X	X		X	
[140]	Nonprofit and Voluntary Sector Quarterly		X	X		X	
[141]	Physic A: Statistical Mechanics and Its Applications		X	X		X	

¹ Type of study according to the time sequence, T: Transversal; L: Longitudinal; According to the evaluation, Ex: Experimental; CS: Case study. ² Type of collection method, D: Direct; M: Mixed.

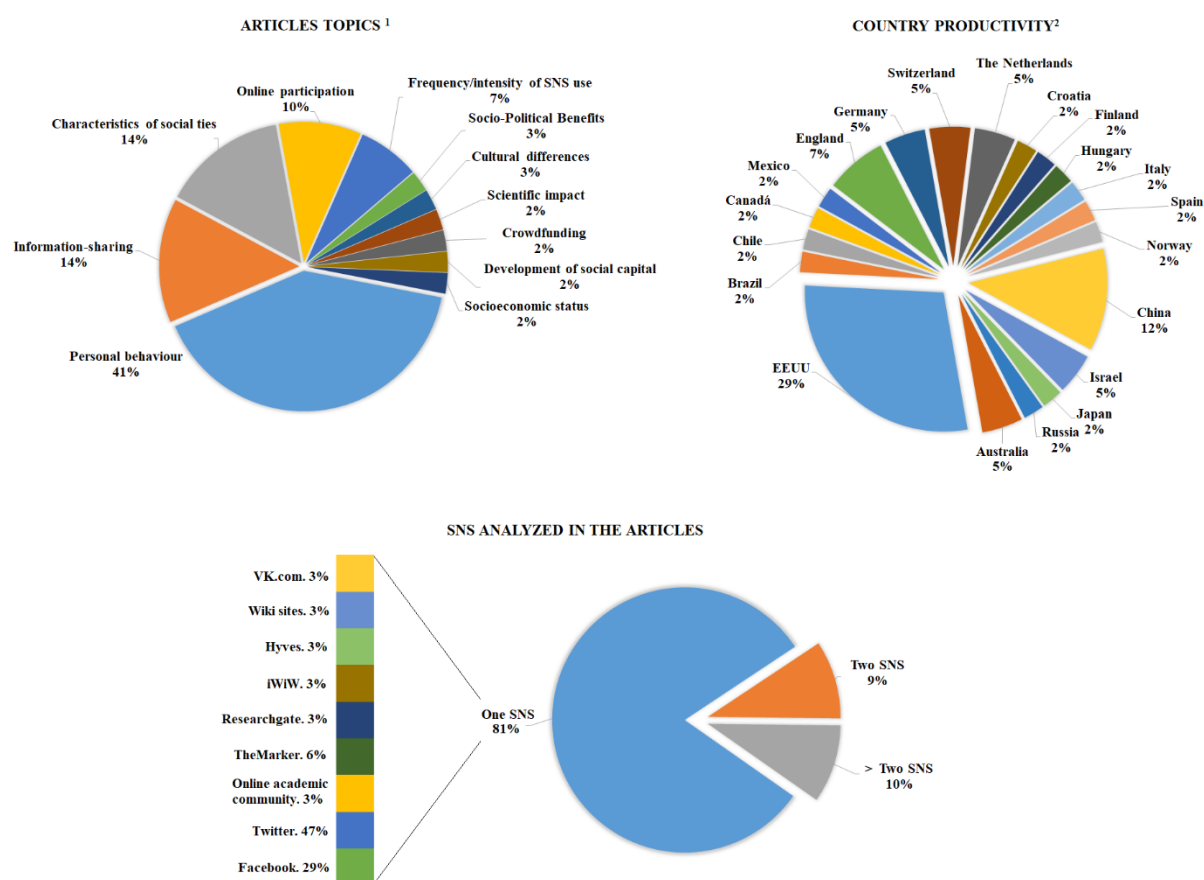


Figure 3. Overview of research on social capital in SNS (own elaboration). ¹ Data were organized according to the categories proposed by [66]. ² First author's country.

Second, according to the time sequence: Transverse or Longitudinal (field "Design and Method"), most publications have a longitudinal design (36). They have analyzed massive data collected over time [142] in order to obtain information about a process of change in a specific behavior (i.e., variations in the position of the network and in participation, among others), to estimate incidents, to anticipate some ideas, or even to identify the causal pathways linking social connections and accessibility to resources [143].

Third, according to the evaluation, experimental or case study (field "Design and Method"), the total of the articles are empirical studies evaluated by analysis of factors affecting certain activities or actions. Furthermore, it can be observed that 95.2% have measured causal relationships to answer their research questions and to test hypotheses.

Fourth, among the selected articles, 21.4% used a mixed data collection method; i.e., they combined a data generator from the same SNS with questionnaires or surveys

(face-to-face and online, most of them adapted to the proposals of Ellison et al. and Williams [69,75]). The remaining articles (33) used direct collection from the SNS.

Fifth, in Figure 3, the subtopics dealt with in the literature on the field of study are presented. For their identification, publications were reviewed and organized according to the categories of topics proposed by J.R. Williams [66] as a framework for codification. This provides an approach to determining how researchers have integrated social capital into online social network models. Thus, 17 of the total number of articles focus on analyzing the aspects of user behavior in SNS that promote some characteristics of social capital based on the perspective of networks. For example, some studies examined that engagement, social awareness, and the search for and selection of friends can facilitate access to and the accumulation of benefits regarding social capital in the SNS [108,132].

Sixth, the selected articles have been published in approximately 20 different countries. According to the institutional affiliation of the principal researcher, the most productive continents in the field of study are America (16 articles) and Europe (15 articles). In the Americas, high productivity is concentrated in the United States (12), which has the highest number of records in the entire geographical distribution. In Europe, the most productive country in terms of research on social capital in SNS is England (3).

Finally, the two SNSs most widely studied in the selected articles are Twitter (22 publications) and Facebook (14 publications). It should be noted that 16 articles considered Twitter and 10 articles consider Facebook as the only SNS, and 19% of the publications used two or more platforms to compare trends between different variables.

4.2. Descriptive–Qualitative Analysis

This section has grouped together the way in which the research reviewed has addressed the measurement of social capital in SNS from a network perspective. Reference is made to content analysis, in which patterns that correlate the measurable characteristics of social capital in SNS have been identified, and research is highlighted only where necessary in order to illustrate differences or particularities.

To this end, a process of disaggregation of the concept of social capital was conducted, taking it to the most concrete level possible [144,145]. First of all, and based on the literature, the categories that integrate the above-mentioned approaches to social capital were assigned. Second, each category was defined with the characteristics of the corresponding social capital, which are specified in this document as the variables of social capital. Third, the elements that enable the characteristics of social capital to be described and explained in measurable terms were identified and are specified in this document as network indicators. Finally, the operationalization of the social capital variables is presented from the perspective of networks, as are some SNS metrics that can be applied for their measurement.

4.2.1. Social Capital Variables

In the literature, social capital has been represented and evaluated following various characteristic variables that will depend on the context of the study. In Table 5, the variables that have been analyzed in the articles selected as elements of social capital are presented; these have been grouped according to the approaches adopted in this research.

Table 5. Variables of social capital (own elaboration).

Approaches/Categories		Variables	Description of Social Capital Variables	Reference ¹
Ties-Type	Bonding Form	Bonding social capital	Ability to gather and maintain a group based on support, commitment, and social solidarity	[34,42,104,119]
	Bridging Form	Bridging social capital	Ability to reach new networks and social groups to create new benefits	
Resources	Structural Dimension	Social connectivity	Ability to be socially close, to bond, to a member in the network	[34,132]
		Structural configuration	Structural characteristics of a social network	[43,76]
		Structural diversity	Diverse social contexts, reflected in groups of neighbors, to which an individual is exposed as a member of a social network. It is considered a key factor for predicting decision making [43,45]	[141,146]
	Cognitive Dimension	Exchange by affinity	Affinities identified and shared through the exchange of language and narratives among members of a social network	[36,131,147]
		Social cohesion	Ability to keep members of a social network together by sharing common standards, values, ideas, and beliefs	[148]
	Relational Dimension	Social contagion	Spread of behavior patterns among members of a social network	[135]
		Social identity	Result of the interaction between members when identifying and comparing themselves with the group to which they belong	[137,149]
		Social influence	The extent to which a member directly or indirectly affects the thoughts, feelings, and actions of others	[123,138,150]
		Social interaction	A process by which members are connected, create ties, and allow access to and exchange of resources	[36,43,151]
		Prestige	A measure of the relationship between members	[152]
		Engagement	Actively contributing interventions that facilitate greater communication and resource sharing	[108,120]
		Popularity	A measure to evaluate the behavior of a member in relation to others in a network	[115,116]
		Reciprocity	A measure of a member's interaction with other network members that promotes the implicit sharing of resources	[7,126]
		Reputation	A measure of the recognition of the success of a member	[115]

¹ Main references that support the description of the variables adopted in this work.

- *In the Ties-Types Approach*, bonding social capital and bridging social capital have been considered as variables, orienting their description in terms of network structure, process condition, and redundant or new benefits [42,104,107,119].
- *In the Resource Approach*, the variables focus on the economic, cultural, or symbolic benefits from the resources integrated into a social network. These variables have been adjusted to the dimensions of Nahapiet and Ghoshal [32].

4.2.2. Network Indicators

A social network is a set of members connected by a group of relationships. Therefore, analysis of the social networks involves studying the ties between members, interpret-

ing their function in the light of relationships with other network members, investigating the flow of resources, and discovering the effects present in the connections and the exchange [153]. In the literature, social networks have been represented and evaluated according to various properties, variables, or reticular indicators, which have been grouped in different ways.

In this paper, as proposed by Hanneman and Riddle and Wasserman and Faust [154,155], the indicators have been associated in four groups of properties (see Table 6).

- *Fundamental properties* represent the set of basic indicators that condition the rest of the structural properties.
- *Centrality properties* are the indicators that allow the analysis of the different positions that the members occupy within the network, identify those who have greater ties with others and know who stands out among the others, who exchange and transmit resources [76].
- *Clustering properties* are indicators that study the degree of intensity with which members are connected to each other as a group in a network [156].
- *Position or role properties*, also known as structural equivalence, are the indicators used to compare similarities in member behavior, suggesting the presence of a role or position in the network. Types of ties, relationships, groups, etc. can be compared [155].

Table 6. Network indicators (own elaboration).

Network Properties	Network Indicators	Network Indicators Description ¹
Fundamental	Network size	Number of units forming the network
	Density	Proportion of existing ties over the maximum number of possible ties
	Diameter	Longest distance of all pairs of units in the network
	Distance	Length of the geodesic or shorter path between units
	Scope	Distance at which all units in a network are located
Centrality	Degree centrality	Total number of ties a unit has with other network members. It is evaluated as the relationship between the degree of a unit and the average degree of the network
	Closeness centrality	Sum of the distances linking the units in a network, whether directly or indirectly connected
	Betweenness centrality	Sum of the probabilities that a unit is present in all the geodesics of the other units in the network (Index of the shortest path)
	Flow centrality	An alternative to betweenness centrality calculated under the assumption that resource flows in each link will determine the most likely paths
	Eigenvector	Measurement of the influence of a unit on the network. Privileged position in the network by being connected to many units that are well connected
Clustering	Clustering coefficient	Measure of the degree to which units in a network tend to cluster. Quotient between the number of existing ties of all direct contact units and the maximum number of ties that could exist between them all
	Clique	A group of units in which all members have direct ties with all others, based on closeness, reciprocity, and frequency of ties
	Modularity	Measurement of the strength of division of a network into groups. It is used to detect the structure of a group in the network
	Homophily	Extent to which group members have their closest ties to members who are similar to themselves
	Transitivity	Measurement of connections within a set of network members
Equivalences	Similarity, role or position	Compare the characteristics of the units in a network, namely: ties, relationships, etc.

¹ The indicators description is supported by [154,157].

4.2.3. Operationalization of Social Capital

Although there is general agreement on what social capital is, what creates it, and what it provides, its measurement has been made difficult mainly by the variety of theoretical perspectives that have not provided for the definition of concrete indicators or their operational feasibility [73,158]. In particular, contextualizing social capital from the perspective of social networks enables the observation and progressive measurement of the increase in members' resources when the capacity of access and exchange increases within the network [147,159,160]. However, their operationalization and testing have currently proved to be a maze [161], resulting in a variety of non-unified approaches.

In this section, we explain how social capital has been evaluated in the revised literature, based on the SNA. Therefore, it presents and discusses the network indicators, measures, and specific methods that have been applied to measure the variables of social capital grouped according to the categories detailed above.

Bonding Forms and Bridging

Table 7 presents the set of network indicators that researchers have used to measure the variables in the “bonding form” and “bridging form” categories. For both bonding and bridging social capital, several network indicators have been identified and used for their measurement (see “Network indicators” field).

Table 7. Network Indicators for the evaluation of bonding and bridging social capital (own elaboration).

Social Capital Category	Social Capital Variable	Network Indicators	Method Used to Calculate the Network Indicators ¹			Reference
			D	SE	Description	
Bonding Form	Social capital bonding	Tie strength		X	Software R (Pack SNA)	[105]
		Network size		X	Software iGraph 0.6 and Python	[107]
				X	Computer program using Twitter developer API version 1.1	[119]
		Density	X		Number of existing ties within a community network divided by the maximum possible number of ties	[90]
		Degree centrality		X	Software R (Pack SNA)	[104]
				X	Package iGraph para python	[106]
				X	Package iGraph para python	[107]
		Modularity		X	Louvain method: automated “community detection” algorithm	[90]
		Transitivity		X	Software iGraph 0.6 and Python	[107]
Bridging Form	Social capital bridging	Tie strength		X	Software R (Pack SNA)	[105]
			X		Ec. used by Eagle et al. (2010)	[90]
		Distance	X		Ec. proposed by Scellato et al. (2010)	[90]
		Betweenness		X	Software R (Pack SNA)	[104]
		Clusters		X	Package iGraph para python	[106]
				X	Louvain method	[107]
		Modularity		X	Louvain method	[107]

¹ Method used by researchers to calculate the network variable with which they have considered defining the social capital. D and SE refer to the Descriptive and Structurally Explicit approaches that have been described by Ö. Bodin et al. (2011) [88]. Moreover, the “Description” register details the type of tool used.

These are reticular variables consisting of structural analysis and of three of the four types of network properties.

- For the variable *bonding social capital*, researchers have considered that a high bonding social capital in structural terms means the following:

A greater number of ties equivalent to increases in network size generates a dense network of closed or homogeneous structures, strong ties, with a low number of holes and adequate returns on bonding capital. Lin [42] points out that denser networks with more intimate and reciprocal relationships between members can increase the likelihood of mobilizing resources for others. However, it should be noted that a threshold exists above which capital decreases as the size of the network increases, and that the density varies greatly between networks of different sizes, implying disproportionate ties for each neighboring member [107,119]. Furthermore, the greater the number of ties a group member has, the greater the degree of centrality and the greater the bonding social capital. Therefore, degree centrality implies more interconnections in an internal network, but without indicating how members are connected in the network [104,106,107].

Knowing how well positioned a member is to receive and disseminate resources is operationalized with the degree centrality indicator. Recognizing the degree of network fragmentation into isolated groups of closely connected members reflects the strength of a network's division into sub-networks (sub-groups), and it measures the density of ties within groups compared to the possible ties between them [90,162]. According to Corten [163], social networks in SNS tend to be relatively dispersed and fragmented, assuming high profits are based on resources generated within relatively isolated sub-networks.

It is important to recognize the degree of cohesion between members when measuring the presence of sites of local density, which is operationalized with the transitivity indicator. Regarding the degree of cohesion equivalent to high transitivity, this shows a nucleus-periphery structure with many dense connections in the core, or a multi-core network with few ties between them, but each core having a large number of dense connections. Therefore, transitivity means greater connectivity within the network when groups of cores represent stronger ties than those in the periphery. Since each new tie between separate contexts, which are not closed, reduces transitivity, bonding capital is also reduced [107].

- Among the articles reviewed, the authors have considered for the variable *bridging social capital* that a high bridging social capital means the follows:

There are a relative amount of ties between heterogeneous members, structure holes, and prone to bridging, which is operationalized with the indicator tie strength and distance.

Knowing the (high) degree of interrelationship of the members and those who play the role of gatekeepers is operationalized with the indicator betweenness centrality. Best et al. (2018) consider that identifying information on interconnections and on gatekeepers, as centers for receiving and disseminating resources, is able to show the increase in bridging capital over time.

There are a relative number of social contexts, which can be described with the indicator modularity and clusters. In terms of clustering, by determining the number of different cohesive groups in a network and their structures, it is possible to pinpoint the different places for the access and spread of resources equivalent to the possible distribution of bridging social capital [106,107].

In Table 7, one may observe ("method used to calculate network indicators" field) that the authors of the literature reviewed have evaluated the bonding and bridging social capital from the calculation of network indicators using indeterminate different, non-unified methods and tools, depending on the context and according to the criteria of the researcher. Thus, 73.3% of the network indicators have been defined with mathematical models that link specific structural characteristics or with formally defined methods of the SNA. It can be stated that the structurally explicit approach prevails [88].

Structural Dimension

A wide range of network indicators used to measure the variables of the structural dimension of social capital were identified in the selected literature, and they have been grouped in Table 8.

Table 8. Network indicators for the evaluation of structural social capital (own elaboration).

Social Capital Category	Social Capital Variable	Network Indicators	Method Used to Calculate the Network Indicators ¹			Reference
			D	SE	Description	
Structural Dimension	Social Connectivity	Network size		X	“Shared Count” tool	[126]
				X	Twiteer API	[132]
		Degree centrality		X	Software UCINET 6 and NetDraw	[112]
				X	Software UCINET 6	[113]
			X		Ec. Proposed by Newman (2006)	[122]
			X		Data acquired from a supplier	[89]
				X	Software Pajek (pack SNA)	[131]
			Betweenness		X	Software UCINET 6 and NetDraw
				X	Software UCINET 6	[113]
		Eigenvector		X	Software UCINET 6 and NetDraw	[112]
	Cliques		X	Software UCINET 6	[113]	
	Structural configuration	Degree centrality		X	Software NodeXL	[51]
		In-degree centrality		X	Software NodeXL	[51]
				X	Software Python and NodeXL	[140]
		Out-degree centrality		X	Software NodeXL	[51]
		Betweenness	X		Ec. proposed by Freeman (1977)	[124]
				X	Software Pajek and UCINET 6	[139]
				X	Software Python and NodeXL	[140]
		Modularity		X	Software NodeXL and Gephi	[51]
		Clustering coef	X		Ec. propuesta por Opsahl (2013)	[89]
Transitivity		X		Propuesto por Brooks et al. (2014)		
Structural diversity	Structural holes		X	Software Pajek and UCINET 6	[139]	
	Betweenness		X	Girvan–Newman community detection algorithm	[141]	
	Modularity		X			

¹ Method used by researchers to calculate the network variable with which they have considered defining the social capital variable. D and EE refer to the Descriptive and Structurally Explicit approaches that have been described by Ö. Bodin et al. (2011) [88]. Moreover, the “Description” register details the type of tool used.

- For the variable *social connectivity*, researchers have considered that high connectivity in structural terms means the following:

There are a relative number of connected members characterized by the size of the network. Thus, the more connections a member has, the larger the size of their network and the greater their chance of getting the resources they need. By feeling identified with others, members will feel relevant and more aware of other network members, increasing their sense of being increasingly connected [126,132,164].

There is a general high level of connections present within a network, which is operationalized with the degree, betweenness, and eigenvector indicators. In a way, the breadth

of relationships corresponds to the amount of social capital. Thus, the fact that a member has a high degree indicates a large number of connections, great interest in continuing within the network, and a strong sense of belonging [89,131]. It should be noted that the overall structure of the network is not taken into account when measuring degree centrality [113,122,165]. Consequently, the researchers have based their analysis on the betweenness measure. High betweenness describes whether a member appears as a gatekeeper or a broker of resources, because he or she essentially controls access and dissemination [113]. Researchers also consider eigenvector centrality as an indicator of the central, notable, and important members in the network. Network members with the highest value, equivalent to the number of connections they have, are regarded as the most influential [112,166].

There is an adjusted number of members fully connected to as many network members as possible, representing a sub-group. This is operationalized with the cliques indicator, which provides the ability to compare a network member with each of its connections [113].

- For the variable *structural configuration*, researchers have considered that this variable can be related in terms of the following:

Centrality: degree, in-degree, out-degree, and betweenness. On the one hand, we need to determine the number of members who are connected to each other by identifying the number of followers and those they follow. This allows us to predict the location of each one in the network; who is most appreciated; who has a larger audience, and who is rewarded for the resources received. On the other hand, doing so can capture the relative importance of a member in the network during the transfer of resources.

Clustering: modularity, clustering coefficient, and transitivity indicators. The first one is used to determine the quality of groups by identifying if they are highly connected within the network. The second one is used to observe the level of cohesion of a network through the knowledge of the degree of interconnection that the members have with others that form their direct environment. The third can show the transfer of resources in closed and disconnected groups within the network [89,156]. The clustering coefficient is often referred to as transitivity.

Role: with structural holes to assess the extent to which a network member can control the flow of resources. This indicator is used to connect neighbors who are not connected to each other. Furthermore, it is evaluated by calculating aggregate constraints on network members. In other words, members with fewer restrictions could have a brokerage position. Therefore, these holes may exist by design or intention [139,167].

The measurement of these indicators confirms that alternative ways exist for resources to flow through the network members. If there are a greater number of structural holes, it is necessary for the resource to pass exclusively through the member with the highest betweenness [51,124,139,140]. Furthermore, it is also necessary for different nuclei of close members with many reciprocal ties between them to exist in a network. Should this decrease, a disintegration of the groups will be observed, with the disappearance of borders and a decrease in internal cohesion.

- For the variable *structural diversity*, researchers have considered relating it to betweenness and modularity. Zhang et al. [141] used the measure of betweenness to identify the central members of the network: those that when eliminated would separate some groups from others. These researchers considered that if a network contains groups that are only loosely connected by a few inter-group members, all the shorter paths between the different groups would pass through them. This enabled the detection of groups and sub-groups and thereby reveals the underlying community structure of the network. Brokerage follow-up and group detection was conducted with the modularity indicator.

Likewise, one may observe in Table 8 (“method used to calculate network indicators” field) that the authors have evaluated the variables of the structural dimension of social capital from the calculation of network indicators using non-unified methods and tools.

Thus, approximately 33.3% of the network indicators have been defined with descriptive measures represented with the information from the SNS. Moreover, the remaining group has resorted to mathematical models linking the specific structural characteristics or the formally defined methods of the SNA, given which it can be stated that the structurally explicit approach prevails [88].

Cognitive Dimension

Table 9 presents the set of network indicators that researchers have used to measure the variables of exchange by affinity and social cohesion. The network aspects of these variables are related to shared narratives, codes, and language.

Table 9. Network indicators for the evaluation of cognitive social capital (own elaboration).

Social Capital Category	Social Capital Variable	Network Indicators	Method Used to Calculate the Network Indicators ¹			Reference
			D	SE	Description	
Cognitive Dimension	Exchange by affinity	TimeStamp		X	Package de SNA—software Pajek	[131]
		Degree centrality		X	Package de SNA—software Pajek	
		Clusters		X	Software UCINET 6 and NetDraw	[112]
				X	Computational Coh-Metrix Tool	[118]
				X	Text Analyzer	[126]
			X		Number of retweets under the #ConvictTRF4, #SupportLulainPOA	[129]
				X	Louvain method	[135]
				X	SentiStrength tool	[138]
		Modularity		X	Software Gephi and R	[135]
	Social Cohesion	Degree centrality		X	Software Gephi-ForceAtlas algorithms	[109]
		Betweenness		X		
		Closeness		X		
		Eigenvector		X		
		Path Length		X		
		Clustering coef		X		

¹ Method used by researchers to calculate the network variable with which they have considered defining the social capital variable. D and EE refer to the Descriptive and Structurally Explicit approaches that have been described by Ö. Bodin et al. (2011) [88]. Moreover, the “Description” register details the type of tool used.

- For the variable *exchange by affinity*, researchers have considered that an adequate social exchange in structural terms means the following:

The frequency with which a network member interacts with others on a specific topic is operationalized with the degree centrality indicator to capture how many pairs of members are interacting in a specific scenario.

The opportunity to trace the linguistic phenomenon and codes given by the intensity of ties between the members of a group or sub-group in a social network [43] is operationalized with clusters and modularity.

Language, together with type of activity, interests, means of exchange, etc., are contextual factors that influence how a member in a network connects to a group or sub-group and accesses the resources available therein [118]. The monitoring and analysis of linguistic style allows for the identification of groups, their structure and cohesion. Furthermore, it recognizes when members within different groups change their language when conversing with other network members [112,126,135].

Using clustering indicators, researchers identified word patterns, syntax, gender of discourse, rhetorical structure, emotional valence, etc. On this basis, it was possible to examine the inclusion of members in certain groups or sub-groups. They were even able to recognize the style of discourse among the ideas with the most significant and central positions, or those members who had performed well in the network [118,129,138].

- For the variable *social cohesion*, researchers have considered that high cohesion in structural terms means, in general, multiple independent relationships between all the pairs of members that hold it together [148]. In particular, the following apply [109]:

The number of members who are connected in groups or sub-groups (with their corresponding support) and the relative number of core members in the network are measured with degree and betweenness, respectively.

An adequate level of resource transmission is required, where the member with less closeness centrality will have less distance to others. Presenting coherence in closeness centrality indicates an equitable distribution of social proximity with other network members.

There is a relative number of members who are connected to other important members in the network, which is measured with eigenvector centrality. This indicates an intensification of activities between members.

Within this framework, structural cohesion is maintained when relationships within a group and formed from a common and justified ideology become evident where discussions and defenses of a particular cause are present. It also has central members who have a high level of intermediation within the social group and who do not allow the network to be disrupted. Moreover, there is usually a segregation with the external groups, and the influence comes from the members toward the group.

As in the previous categories, Table 9 shows (“method used to calculate network indicators” field) that the methods used to calculate network indicators are varied and 90% of measurement tools defined by the SNA are found.

Relational Dimension

Table 10 presents the set of network indicators that researchers have used to measure the variables of relational dimension of social capital. The network aspects of these variables are related to the behavioral assets embedded in social relationships.

- For the variable *social contagion*, researchers have considered that a high contagion in structural terms means the following:

The relative number of steps to go from one member to another is determined with the diameter metric as an indication of the network size.

A relative network size that allows for predicting changes in the dissemination behavior of the members present. Niles et al. [127] suggest that members with medium-sized networks are more likely to connect and broadcast more often than those with larger networks.

A high density, showing that the number of actual ties in a network is equivalent to the maximum possible number of ties. In dense networks, generally small distances tend to exist, suggesting that resources can be transferred quickly, and if the network is not fully connected, it is difficult to define the approximation between members [135].

The most optimal path between members, or geodesic distance, can estimate how far apart one member is from another and how far away he or she is from the person to whom it may be spread.

The number of connected members included in groups or sub-groups can identify who has control over the resources flowing in the network, who receives the most attention, and who allows the resources to reach a larger number of members.

There are members with advantageous positions—that is, positions that have a greater number of ties, with a relative distance to other members in the network and with one of the central positions, or as close as possible, that allows for greater access and benefits from intermediation, as well as a high exchange and sharing of resources [110,135].

Table 10. Network indicators for the evaluation of relational social capital (own elaboration).

Social Capital Category	Social Capital Variable	Network Indicators	Method Used to Calculate the Network Indicators ¹			Reference
			D	SE	Description	
Relational Dimension	Social contagion	Distance		X	Software Gephi and R	[135]
		Diameter		X	Software Gephi and R	
		Density		X	Software Gephi and R	
		Network Size		X	Twitter's streamming API	[127]
		Degree centrality	X		Calculated by equation	[110]
				X	Software Gephi and R	[135]
		Closeness	X		Calculated by equation	[110]
				X	Software Gephi and R	[135]
		Betweenness	X		Calculated by equation	[110]
				X	Software Gephi and R	[135]
	Social Identity	Clusters		X	Software Linguistic Inquiry Word Count	[104]
				X	Software Linguistic Inquiry Word Count	[105]
			X		Eq. Euclidean & Jaccard-Distance	[137]
	Prestige	Modularity		X	Maximization algorithm	[137]
		In-Degree		X	Software Pajek64 3.12 and UCINET 6	[139]
		Betweenness		X	Software Pajek64 3.12 and UCINET 6	
	Engagement	Tie Strength	X		Information taken from user profiles	[108]
				X	Software Python and NodeXL	[140]
		Network Size	X		Information taken from user profiles	[108]
				X	Software Python and NodeXL	[140]
		Degree		X	Software UCINET	[120]
				X	Software NodeXL and Pajek	[130]
		Out-Degree		X	Software Gephi	[129]
				X	Software NodeXL and Pajek	[130]
		In-Degree		X	Software NodeXL and Pajek	[130]
		Betweenness		X	Software NodeXL and Pajek	
		Closeness		X	Software NodeXL and Pajek	[120]
		Homophily		X	Software UCINET—E-I Index and QAP	
		Clusters		X	Louvain method	
	Social interaction	Density		X	Software NodeXL	[51]
				X	Software R (pack SNA)	[105]
		Degree		X	Software UCINET 6 and NetDraw	[112]
				X	Software iGraph	[118]
			X			[134]
		Out-Degree	X		Dataset published by Illinois University Rui et al. (2012)	[134]
		In-Degree	X			

Table 10. Cont.

Social Capital Category	Social Capital Variable	Network Indicators	Method Used to Calculate the Network Indicators ¹			Reference
			D	SE	Description	
Relational Dimension	Social Influence	Betweenness		X	Software R (pack SNA)	[105]
				X	Software UCINET 6 and NetDraw	[112]
				X	Software iGraph	[118]
				X	Software NodeXL	[51]
		Eigenvector		X	Software iGraph	[118]
				X	Software UCINET 6 and NetDraw	[112]
		Closeness		X	Software iGraph	[118]
		Clusters		X	Software VOSmapping and Pajek	[139]
		Transitivity	X		Ec. by Newman (2006)	[122]
		Modularity	X		Ec. by Newman (2006)	[122]
				X	Software Gephi	[129]
		Homophily		X	E-I Index with UCINET 6	[139]
		Brokerages Roles		X	Software NodeXL and Gephi algorithm	[51]
		Tie Strength	X		(a) Social context of the relationship; (b) Recent relationship; (c) Common interests; (d) Frequency of interaction	[102]
		Density		X	Package of Python	[111]
		Diameter		X	k-shell (or k-core) decomposition method	[138]
Relational Dimension	Social Influence	Path Length		X	SmartSocial model and other algorithms	[136]
				X	k-shell (or k-core) decomposition method	[138]
		Network Size		X	R Core Team (2014)	[128]
		Degree Centrality		X	Package of Python (Sanp.py by Stanford)	[111]
				X	Calculated by equation and algorithms	[123]
				X	SmartSocial model	[136]
				X	k-shell (or k-core) decomposition method	[138]
		In-Degree Centrality		X	Software NexaIntelligence by Nexalogy	[114]
				X	Software Gephi	[129]
		Betweenness	X		Eq by Brandes (2001) & using R	[128]
			X		Eq. by Latora and Marchiori (2007)	[133]
		Closeness		X	Package of Python	[111]
		Embeddedness		X	Commercial application hosted Facebook	[102]
				X	Python and NodeXL	[140]
		Eccentric		X	Package of Python	[111]
		Network Overl.	X		Eq. by Peng et al. (2018)	[117]
Relational Dimension	Social Influence	PageRank		X	Package of Python	[111]
				X	Models influence propagations	[123]
			X		Eq. by Langville and Meyer (2003)	[133]
		Coreness		X	k-shell (or k-core) decomposition method	[138]

Table 10. Cont.

Social Capital Category	Social Capital Variable	Network Indicators	Method Used to Calculate the Network Indicators ¹			Reference
			D	SE	Description	
		Alphacentrality		X	Models influence propagations	[123]
		TrueTop	X		Eq. by Zhang et al., 2015	[133]
		Cluster		X	Software Linguistic Inquiry Word Count	[114]
				X	SentiStrength tool	[138]
			X		Twitter biographical descriptions	[140]
		Modularity		X	SmartSocial model	[136]
		Transitivity	X		Calculated by equation	[117]
		Clustering coefficient		X	Package of Python	[111]
				X	SmartSocial model and other algorithms	[136]
		Homophily		X	Software NexaIntelligence & LIWC	[114]
	Popularity	Network Size	X		Ec. by Burt (2009)	[121]
		In-Degree	X		Information taken from the SNS	[115]
				X	Software Pajek64 3.12 and UCINET 6	[139]
		Degree	X		Number of posts, views, comments, stars	[116]
			X		Ec. by Burt (2009)	[121]
			X		Ec. by Freeman (1979)	[124]
Reciprocity		Eigenvector	X		Calculated by equation	[121]
		Out-Degree	X		Dataset published by Illinois University Rui et al. (2012)	[134]
		Clustering coefficient	X			
Reputation		Clusters		X	Software Linguistic Inquiry Word Count	[125]
		In-Degree		X	Software UCINET/Netdraw	
		Betweenness		X	Software UCINET/Netdraw	
		Closeness		X	Software UCINET/Netdraw	
		Eigenvector		X	Software UCINET/Netdraw	
		In-Coreness		X	D-core decomposition analysis	
		Homophily		X	E-I Index—software UCINET/Netdraw	

¹ Method to calculate the network variable. D and SE refer to the Descriptive and Structurally Explicit approaches by Ö. Bodin et al. (2011) [88]. Moreover, the “Description” register details the type of tool used.

- For the variable *social identity*, researchers have considered that high identity in structural terms means the following:

There is a relative frequency of interaction between members on a particular topic; depending on the group or sub-group, this shows changes in their linguistic behavior. Tamburrini et al. [137] state that members are implicitly or explicitly aware of the social identity of a partner and change their use of language in a certain way. This is mostly due to how isolated such a group is from the rest of the network.

Monitoring and analysis of the linguistic characteristics that allow the identification of the groups, their connectivity, and coherence. Bliuc et al. [105] found that the use of words as markers of identity (i.e., we) during interactions promotes bonding and permanence in the group. The same is true for validation or endorsement by group members, which is reflected in the “likes” or “comments” received. In this way, the perception of a positive state of a group increases the perceived attractiveness and desire to belong to it, since it contributes to the achievement and maintenance of a positive identity.

- The variable *prestige*, as proposed by Vergeer [139], has been related to centrality indicators such as in-degree and betweenness. Specifically, the author has evaluated the large number of members of a network that connect with others, considering indirect relationships and distances. He has even identified the intermediaries that use the absence of relationships between neighbors for their own benefit, emphasizing participation between members who are not directly related [53].
- For the variable *engagement*, researchers have considered that high engagement in structural terms means the following:

There are a relative number of members with whom another member is involved in a specific topic and a number of groups to which he or she belongs. This has been evaluated with the tie strength and the network size [108,140]. According to Carlisle and Patton [108], network size is defined as the number of “friends” in a social network, which is not significantly related to engagement. The authors suggest that creating a social network in an SNS is an independent activity undertaken by users who are less inclined to engage. Therefore, members who have more connections are less likely to be active on a particular topic. This is contrary to Xu and Saxton [140], who consider that the level of effective engagement depends on how much and how well the members of a network are connected. In particular, they propose that meaningful engagement occurs to the extent that there is a diversity of ties and content.

There is an adequate structural position, which has been evaluated with degree, out-degree, in-degree, betweenness, and closeness [120,129,130]. The frequency with which the member has been contacted or has contacted other members of the network has been recognized (in, out, respectively). In order to achieve a high out-degree, the member must establish various ties in different interactions. However, for in-degree, this is not necessary; the member can be mentioned in a relationship without actually participating in it [129]. Therefore, the position of a member is based on the relationship of “giving and receiving” he or she has with others. By creating, dedicating, and maintaining these ties, members of a network are able to achieve a central location that allows them to access, master, and direct the transfer of various resources [130]. In this regard, Bourdieu [37] stipulated that having an optimal location increases participation and social capital within an SNS.

There is a relative number of sub-groups within the network, which is operationalized with clusters and homophily. Mechanisms are identified for forming close ties with members who are similar, thereby achieving greater participation in related issues. It should be noted that larger groups are driven by a dominant member who is able to bring others together, cover the main transmission issues, and promote the widest possible engagement [120,130].

- For the variable *social interaction*, researchers have considered that high interaction in structural terms means the following:

There is a relative number of ties within the network in relation to its size [51]. The number of interactions was captured by the number of ties provided or received, representing all interactions between members [105,112,134].

There is an adequate structural position: that is, knowing the quantity and quality of interaction within a network. High degree scores imply high interaction or activity levels between members. Interaction is likely to require more effort in order to be well connected: i.e., the recognition of common interests within the network. To that end, the quality of interactions was captured with betweenness, closeness, and eigenvector [112,118]. This is because the more central a member is in a network, the greater the sense of belonging, thereby strengthening interaction and creating collaborative groups with well-connected members. Even in the case of members with low degrees, new pathways can be found to link the core with various sub-groups that may exist on the periphery.

There are a relative number of brokerage roles, which provide a formal characterization of where a member is situated in relation to different groups, who links isolated

groups or individuals, thereby directing the likely pathway of resource diffusion between members [51].

There is structural stability evaluated with the robustness indicator, which describes whether the network maintains its connectivity properties by randomly removing a critical fraction of its members. This enables the critical percolation threshold to be predicted and thereby anticipate significant changes by any sudden failure [122,168].

There is an adequate number of highly connected groups or sub-groups within a network, which is operationalized with modularity, transitivity, and homophily. Once the groups or sub-groups had been identified, the researchers considered it appropriate to measure the quality of each one; one indicator is the difference between the density of the ties within and between the different groups [51,122,162]. More dense ties within a group and less dense ties with other groups indicates high modularity [169]. On the other hand, researchers can identify the scope of the ties by determining the existence of closely knit groups in the network and whether their members are more focused on internal or external relations as a reference for the type of interaction based on similarities.

- For the variable *social influence*, researchers have considered that high influence in structural terms means the following:

There is a relative volume of interaction, which is defined as the tie strength and goes beyond the frequency or intensity that allows the nature of the relationships to be described.

There is an adequate number of confirmed ties between members of a network and an appropriate portion of potentially real ties, allowing the formation of fractions or sets of sub-groups within a larger network to be recognized [111,128].

There is a number of relative ties containing the shortest path, which enables the networks to be distinguished from the rest and shows the difference between the strongly and weakly connected members. This is defined by the average path length and the diameter of the network [136,138].

The number of ties received and total ties in a network are operationalized with in-degree and degree and concerning exchange and relations.

It is possible to know the measure of resource intermediation within a network, which is operationalized with the betweenness indicator and associated with greater opportunities for transmission and influence. A member with high betweenness is regarded as being the most influential in the network: the one with the greatest opportunity to exchange information between different members or groups [105,128].

It is possible to identify the proximity and ease with which a member can reach others in a network, assuming that one can only transmit resources or influence their existing connections [111,170]. This is operationalized with the closeness indicator, the low levels of which indicate that a member is directly connected to most others in the network. Thus, very peripheral members may have high values in closeness, showing the high number of connections they must traverse to connect to more distant ones [171].

It is possible to measure the proportion of the connections of a pair of members that are shared, which is operationalized with the indicators embeddedness centrality and network overlap.

The localization, dispersion, and simulation of real influences are operated with indicators superior to those of traditional centrality such as coreness, eccentric, True Top, Page Rank, Alpha centrality, etc., which are widely used in applications such as political movements, health, etc. [111,123,133,138].

There is a codification of groups by counting ties, themes, etc., assessing the level of cohesion of the network, and identifying the quality of interaction in terms of who is highly connected, whether they have relationships with similar groups, and whether the relationships are focused on internal or external members. This is operationalized with the clustering, modularity, clustering coefficient, homophily, and transitivity indicators.

There are changes in two properties that accompany influence propagation models, submodularity and monotonicity. These represent the contribution of recently connected

members to those previously connected and the fact that linking new members cannot reduce the size of the global network.

- For the variable *popularity*, researchers have considered that a high popularity in structural terms means the following:

There is an effective size associated with resource mobilization in the network, which is represented as the number of members linked to a member who are not connected to any neighbor as a redundant tie. Lesser et al. [121] report that in large networks, members are able to reach out to others while building bridges to additional network segments, thereby mutually increasing their popularity. Specifically, they found that degree and in-degree are strong indicators of popularity because they denote the number of ties a member has within the network and because the network is formed by direct and explicit actions over time.

There is an adequate structural position evaluated with degree, in-degree, and eigenvector. Popular members have a high degree and/or in-degree because they have a relative number of ties and members who want to connect with them [115,116,124,139]. Thus, popularity implies the importance of members in the network, that is, the degree to which the network is connected to others who are popular [172]. The eigenvector indicator allows the assignment of scores to all network members. This is based on the principle that members are more popular when linked to high-scoring members than those connected to low-scoring members.

- For the variable *reciprocity*, researchers have considered that high reciprocity in structural terms means the following [134]:

There is a high out-degree value, which is determined by members of a network interested in connecting with others to share resources.

Members of a network are closely linked with others, forming groups or sub-groups. They are categorized in terms of emotional content attributed to their behavior in interactions.

The number of members linked to others that are connected to each other is determined with the clustering coefficient.

- For the variable *reputation*, researchers have considered that a high reputation in structural terms means the following:

A favorable position in the network structure is more central and more visible. Centrality indicators measure [125,154] “where the action is” (in-degree), the speed with which one member connects to another (closeness) and the essential resonance or diffusion among many (eigenvector), as well as the control to the access and transfer of resources and the diverse and multiple interaction between members (betweenness).

There is a relative number of members within a group who have close ties with others who are similar to them. This is in order to assess the impact that network members have on others who are prominent in a particular issue [125].

The prominence of a member within the network is directly proportional to reputation, which is identified with the centrality indicators. An appropriate distance from the core of the network to a specific point allows the level of dissemination among members to be measured.

Garcia et al. [115] have considered the definition of reputation with the in-coreness indicator as an alternative approach to discrete models of centrality. Having a high in-coreness is a sufficient condition for having a high in-degree; however, the opposite is not feasible.

As in the categories of social capital reviewed in previous sections, Table 10 show (“method used to calculate network indicators” field) that researchers have used different methods to calculate network indicators and that 69.3% of the measurement tools used have been defined by the SNA.

4.2.4. Metrics of SNS Platforms to Evaluate Social Capital

A variety of SNS platforms have been used in the literature reviewed. The two SNSs most used by researchers are Twitter and Facebook. From the perspective of social networks, these are different SNS platforms [51,124]. On the one hand, Facebook is a non-directional, symmetrical network with two-way ties, quite the opposite of what Twitter is as a network (it contains larger, diffusely defined specific groups and facilitates new links). On the other hand, each has a group of metrics that are characteristic for communication activities and that manage to represent favorably a certain network topology of a member.

It was found that researchers have approached the measurement of social capital from the relationship between its variables, network indicators, and SNS metrics. It is highlighted that first, there is non-unified consensus, either on Facebook or Twitter, on which metrics should be used in the network indicators describing the variables of social capital. The selection of indicators and metrics depend on the application context and the establishment of the network [121,173]. Second, social capital variables exist that have been related to indicators that are not part of the analysis of social networks. Third, some social capital variables have been determined with direct Twitter metrics, such as “Tweet frequency” and “Hashtag frequency”. Fourth, some social capital variables have not been related to specific network indicators and have been measured directly with SNS metrics.

5. Conclusions

In this work, a review is conducted focusing on the analysis of the most relevant publications that enable us to identify how research on social capital in SNS presents its characteristics and the way in which it has been measured from the perspective of social networks. To this end, a structured process is followed in which methods derived from bibliometrics are applied, some of which are methodological in nature and others involved reviewing the content of the literature. Although the study of the subject of research at an academic level is recent, it is important to point out the following:

- (A) Regarding the analysis of bibliographical information: first of all, trends in the evolution of publications and indicators of popularity and influence, taken in moderation, give an indication of the possible recognition or growing legitimacy of the field of study as a viable research topic. Secondly, there is a high dispersion and a lack of maturity of the field of study due to a high disaggregation of articles in different journals and the wide range of contextual sub-themes. Thirdly, research in the field of study focuses on analyzing aspects of user behavior in SNS that promotes some characteristics of social capital.
- (B) Regarding the descriptive–qualitative analysis: first of all, there are different interests involved in investigating how the characteristics of the SNS affect the ability to access, generate, or maintain resources in a social network. The articles reviewed range from understanding the factors that improve behavior, participation, engagement, social connectivity in SNSs to demonstrating that resources embedded in a network structure provide information [89,90,104,108,116,121,124,128,132,138,139].

Second, even in studies that do not explicitly refer to social capital, they nevertheless describe resources incorporated into in a community and managed in an SNS. Some of these studies are particularly based on concepts such as social contagion, influence, identity, or social cohesion, and therefore, they refer implicitly to social capital [127,174,175]. They constitute relevant research because they provide information on how components of social capital are addressed in SNS platforms.

Third, under the conception that social capital can be specified from the ties-type approach and the resource-type approach, 88% of the literature reviewed underlies the latter, either by focusing particularly on the relational dimension or on the structural dimension [114,116,117,120,125,130]. In this sense, the researchers considered to explore the level of social engagement and participation in an SNS [104,108], reveal patterns of interaction and influence between members [122,123], define the network structure of

complex communities [51,131], or demonstrate that the resources embedded in a network structure provide important information [118,124].

Fourth, the level of analysis that predominates for both ties-type and social capital resource-focused articles is that of the network member as an individual, not as a group. Furthermore, the articles focus on the characteristics of the member (i.e., gender, age, ideology, education, seniority in the network), on the characteristics of the ties (i.e., strong, weak, or new type of interaction) and on the context of the network, where the academic stands out.

Fifth, although there is a direct relationship between social capital variables and social network properties, there is no consensus among researchers to describe the categories of social capital with clearly unified network indicators. Likewise, there are no consolidated SNS metrics with which the network indicators and social capital variables are measured. It is commonly affected by the application context and by the type of network. Even no clear understanding exists of the appropriate elements of the social network perspective and SNS platforms that assess resources and ties over and above user behavior or conduct.

Sixth, of the four types of network properties with which researchers have described the social capital variables, centrality has been found to be the most used because it is used to measure, on the one hand, the importance of certain members within the social network and how well they are positioned to receive and disseminate information [110–112]. On the other hand, it is also used to find changes in the cohesion of the network that enable identification of the variation of the types of ties over time [104].

Finally, an ordered framework of key elements and a set of indicators is available to measure social capital in SNS platforms from a network perspective. Herewith, it is possible to understand the benefits that a company acquires participating in SNSs by analyzing the notions of social structure, interactions, as well as connection patterns and norms. This helps to understand the contributions to the growth and well-being of society and, in turn, to the understanding of the social dimension of sustainability in virtual sites [176].

Social capital is by no means the remedy for the problems of sustainable development; however, it is a relevant concept for the field of sustainability, as it offers a measurable form and favors the creation of knowledge in companies and the promotion of sustainable practices for economic, environmental, and social purposes [101].

Limitations and Future Research

The review presented in this paper, on the measurement of social capital in social networking sites, is based on a sample of research articles that analyze the phenomenon from a social network perspective. It does not consider articles that examined social capital in traditional media or articles that used surveys or questionnaires as data collection instruments. On the one hand, this is justified by the authors' interest in analyzing and unifying the way in which social capital is measured in bidirectional communication platforms, such as SNS platforms. On the other hand, it is justified because of the interest in learning about tools that make it possible to extract a greater diversity of information available in social networks. This is possible because the relationships in SNS platforms leave digital traces that make it possible to obtain massive amounts of data and automatically.

In this study, the network perspective has been selected to describe and explain social capital approaches in measurable terms. Although this perspective is supported by a widely accepted theory, future research may use a theoretical approach that combines several perspectives capable of bringing greater understanding to the field of social capital measurement in SNSs.

On the other hand, the results obtained provide a foundation for the development of tools and methods that facilitate the extraction of data from a relationship-building infrastructure such as SNSs, as well as the visualization of the social network through the measurement and analysis of social capital in the domain of communications performed in SNSs. In addition, the existence of these automated and efficient methods of measuring social capital opens the possibility of research on the relationship between sustainability,

the communication of responsible initiatives of companies in their SNSs, and the generation of social capital.

This study has analyzed how to measure social capital on SNS platforms, which is one of the factors that determines social sustainability. However, an analysis that integrates social capital with other factors, physical and non-physical, could identify the growth of the social dimension of corporate sustainability and its synergy with the other dimensions in SNS platforms.

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