

Article

Adoption of Social Media in Socio-Technical Systems: A Survey

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Abstract: This article describes the current landscape in the fields of social media and socio-technical systems. In particular, it analyzes the different ways in which social media are adopted in organizations, workplaces, educational and smart environments. One interesting aspect of this integration, is the use of social media for members' participation and access to the processes and services of their organization. Those services cover many different types of daily routines and life activities, such as health, education, transports. In this survey, we compare and classify current research works according to multiple features, including: the use of Social Network Analysis and Social Capital models, users' motivations for participation and organizational costs, adoption of the social media platform from below. Our results show that many of these current systems are developed without taking into proper consideration the social structures and processes, with some notable and positive exceptions.

Keywords: social media; socio-technical systems; feral systems; firms; nonprofit; smart cities



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1. Introduction

Information technologies are increasingly intertwined with human organizations and processes in most areas, including businesses, firms, education, assistance, administrations, etc. This kind of integration is giving rise to so-called Socio-Technical Systems, which show tighter integration and more blurred borders between the technical and social spheres, by the day. Correspondingly, especially for large systems, their development is becoming challenging, since it requires attention to multiple aspects, including social and technological requirements and issues. The pervasive diffusion of capable devices, both at home and in mobility scenarios, with powerful processing and communication capabilities, further fuels the emergence and development of such systems, giving rise to Internet of Things (IoT) [1] and Pervasive Intelligence [2] scenarios. In fact, in these computational environments, new applications are being developed, integrating wearable devices with home computing, mobile phones with smart infrastructures, social media with mapping and geolocation, etc.

In many cases, Socio-Technical Systems act as “systems of systems”, since they support the interconnection of multiple social systems [3], generating and processing information in many repetitive, tedious or hazardous tasks [4], also for disaster recovery. In these cases, diverse conflicting requirements, expressed in different notations and according to different models, may make the development particularly difficult. As a typical real case, social media are being often integrated with other technical systems and social structures and processes. This kind of development requires to have a clear vision of the possible advantages, costs and risks of the integration [5].

Considering urbanization phenomena, they offer opportunities in terms of economic and social life, but also several technological challenges when designing novel tools to improve the citizens' quality of life. Indeed, as the population increases, urban issues like traffic jams, pollution, overcrowding, disaster recovery, management of resources like water and energy become crucial to monitor and govern. Moreover, municipalities and local governments are going to increasingly offer their services using ICT technologies to reduce

costs and to make it easier for their citizens to access their services. The e-government is an extensive part of a typical smart city environment and nowadays its role is highlighted because of the social distancing measures to control Covid-19 pandemic all over the world. Smart cities and e-government are going to have a significant impact in people's daily lives. For this reason, to design these services, Socio-Technical Systems represent a fundamental point of view to build e-services with people as a target and not around them. Several research works have highlighted the most important aspects and pillars that a smart city should have, but less attention has been focused on human issues with technologies such as: spontaneity and adoption from below or embedding users' motivations in the design of these kinds of applications.

This article firstly presents a general introduction about the evolution of Socio-Technical Systems from their more traditional scenarios to more modern applications, then the most consolidated **models and theories** for studying the development of social networks, their members' motivation for participation, issues and costs of integrating social media in various Socio-Technical Systems. In fact, we argue that this kind of studies are fundamental for fully understanding the requirements in complex scenarios, involving technological, human and societal aspects.

The main contribution of this research work is a comparative analysis focused on **current systems**, being developed in various different contexts: use of social media as feral systems, integration in businesses and firms, non profit organization and agencies, smart environments and e-government. Such systems, which are presented in the contemporary scientific literature, are compared and classified according to multiple features, including: the use of Social Network Analysis and Social Capital models, users' motivations for participation and organizational costs; adoption of the social media platform from below, in a mostly spontaneous way, or dictated from managers, with the possible presence of facilitator and social media architects; availability of results or definition of an evaluation methodology; use of popular platforms or *ad-hoc* systems, based on open or proprietary protocols and code.

The most interesting results obtained by this research work show many interesting achievements and various weaknesses in the way that some of these current systems are developed. In fact, many of them do not take into proper consideration the social structures and relations, both before and after the development of an integrated system, with some notable and positive exceptions. However, a number of the works that we have analyzed provide a discussion of motivations and costs, which may drive the users' concrete participation in the integrated system. Also about the evaluation of results, the situation is quite mixed. We believe that, after some failures in the early adopters of social media platforms, there is increased awareness of the complexity and depth of the task at hand, which requires a careful development taking into account all the various aspects of the whole resulting Socio-Technical System.

2. Socio-Technical Systems

The term Socio-Technical System (STS) was originally coined by Emery and Trist [6] to describe systems that involve the environmental aspects of the working system and a complex interaction between humans and machines. Nowadays, this term is generally adopted to assert that all the factors—people, machines and context—need to be considered when developing organisational processes using the design methods of Socio-Technical Systems. In particular, these organisational systems and processes can be generalized with the concept of complex systems, presenting the following features:

- Systems have an internal environment comprising separate but interdependent technical and social subsystems [7].
- Systems should adapt to and pursue goals in external environments.
- Systems have equifinality: systems goals can be achieved in different ways, so there are design choices to be made during system development [3].

- System performances are evaluated with the joint optimisation of the technical and social subsystems. Indeed, focusing only on one of these systems lead to worse performance and utility [8].

In the early stage, Social-Technical Systems have been used to investigate the organisation of work mostly in the manufacturing sector: coal, textiles, and petrochemicals industries. In particular, the development of the ETHICS method [9,10] aims to make the work in these industries more humanized, in order to move away from a mechanistic view of work which largely relied on the specialisation of work and the division of labour.

As Information and Communication Technologies (ICTs) have become pervasive in the workplace, the focus has moved on the relationships between work and its computer-based supports and how these systems can shape work practices [11]. In such Socio-Technical Systems, it is also important to take into account the evolution of the environment, which may impose a corresponding evolution of the whole developed system. This also requires to take failures into consideration, since the system has to cope with them while remaining operational. A famous example was the XSEL (eXpert SELler) system developed by the Digital Equipment Corporation (DEC) to help sales manager for assisting customers in configuring their VAX computer installations. This system, developed using socio-technical methodologies, permitted DEC to save tens of millions of dollars a year [12].

More recently, we are assisting to a renewal of interest in socio-technical approaches, although socio-technical ideas and approaches may not always be explicitly reported. The ideas appear for example in areas such as participatory design methods. Indeed, one of the key tenets of socio-technical approaches is a focus on participatory methods, which require to involve end users during the design process. However, since the advent of Internet-based services and social media, these methods differ in an important way. Indeed, the historical participatory design principles required users to effectively move into the territory of system developers. Collecting Big-Data from Social Media platforms, such as user-generated contents, localization services and interactions, lead to the adoption of the inverse view. It put the developers into the users' world as part of the development process [3]. Moreover, this breakthrough in social participation enabled the design of innovative applications in several contexts: e.g., work organization, public-safety, e-government services. In this article, we aim to review what is the level of integration of social media in these contexts and how the novel social-technical principles are effectively adopted.

3. Theories of Social Networks

A social network is defined by Wasserman and Faust [13] as a set of actors and the relations defined on them. The study of the structural and topological features of such networks is defined as **Social Network Analysis** (SNA) [14–17].

The theoretical foundations of SNA lie on graph theory, since each social network can be naturally represented as a graph, where each node corresponds to a member of the social network and each edge corresponds to a connection between two members.

SNA has a very large applicability in many research fields, ranging from social psychology, organizational studies and political science to anthropology, biology, economics, geography and information science. In fact, many examples of social networks have existed, long before the emergence of online platforms. Such social networks vary in nature and size, i.e., a group of friends, the employees of a company, sympathizers and contributors to public causes, etc. SNA is used to gather many different insights about a social network, including:

- find users' membership and role in communities
- infer possible relationships among some users
- identify some patterns of users' behaviours
- track changes in network structure over time

For analyzing the participation in social networks, the theories of **social capital** can provide an important perspective. Social capital has received multifaceted definitions, but

essentially it represents the benefit granted by relations with other members of any sort of social network; e.g., those relations can be with family members and relatives, colleagues, or generic contacts. The origins of the concept lie in studies about neighborhood communities in large cities. In particular, Jacobs [18] uses it to describe the dynamics of collective actions and the enduring trust bonds which develop together with the experiences of cooperation. The concept of social capital has been used also for studying competitive scenarios, as firms [19], nations [20] and geographic regions [21]. Moreover, social capital is attributed an important role also in the development of human capital [22,23]. A rough estimation of the social capital can be based on the size of the ego-centered social network. In fact, homogeneous and richly interconnected groups certainly share information rapidly among their members. However, according to Burt [24] social capital is more precisely related with the number of *non-redundant* contacts, rather than the simple number of contacts, capitalizing on the observation of Granovetter [25]. Granovetter argues that members connected with people outside the group play the most important role, for introducing new ideas and opportunities into the group, distinguishing three types of ties: (i) *strong ties*, as those with relatives, (ii) *weak ties* or simple acquaintances, and (iii) *absent ties*, marking missing relations in the network. Burt emphasizes the importance of the absent ties, which create the “structural holes” in the network texture. Thus, individuals may greatly increase their social capital by creating a weak link among two otherwise separated communities. The role of social capital inside organizations is discussed by Nahapiet and Goshal [26], distinguishing various aspects of social networks in building intellectual capital: (i) *structural*, i.e., patterns of connections among actors and properties of the whole social system; (ii) *relational*, i.e., types of ties developed during interactions, like friendship, trust, and respect; and (iii) *cognitive*, i.e., basic systems of meaning shared among actors, including knowledge, representations and languages. Contractor and Monge [14] discuss various motivations, which can guide users to create social connections, according to a Multi-theoretical multilevel (MTML) model. Their multi-faceted approach considers the following aspects, which may drive the members’ actions: self and mutual interest [27,28]; homophily and proximity [29]; exchange and dependency [30]; co-evolution [31,32]; contagion; balance and transitivity; cognition and transactive memory [33].

4. Motivations for Online Participation

Though Online Social Networks are a new phenomenon, their analysis can still exploit many of the results obtained in decades of studies of human networks. However, the different context of online relations also requires specific theories and methodologies, together with the adaptation of more traditional network models to the different structure and dynamics of online networks. Moreover, many different online social networking platforms exist and are used by quite different types of users and for quite diverse activities, consequently based on greatly varying technologies and architecture. Since online networks greatly differ from traditional ones, also the motivations for users’ participation and engagement are different. In particular, to understand the conditions which guide users to share their valued knowledge in online communities, it is necessary to analyze: (i) the role of both online and offline reputation, and (ii) the kind of relationships developed in a specific community. One interesting example is constituted by online Networks of Practice. Wasko and Faraj [34] analyze a public online forum about legal issues, where professionals participate using their real identities. Similarly to the MTML model, the following factors are studied, according to their role in encouraging users’ participation:

- **individual benefit**, expected by a member from his/her contribution, even without direct acquaintance and without mechanisms encouraging reciprocity; online and professional reputation is often one of the most important expected benefits;
- **structural capital**, number and strength of connections and the associated habit of cooperation and propensity for collective actions; in fact, a central position in the network strengthens a member’s willingness to contribute, and vice-versa;

- **relational capital**, personal relationships and trust among members, perceived commitment and reciprocity, acceptance of common norms;
- **cognitive capital**, required for any meaningful interactions between members, in the form of basic shared understanding and semantics, including contexts, norms, languages, interpretations and narratives.

In the specific forum analyzed in [34], a crucial role is played by reputation, since the participants' online identity corresponds to the real one and thus the online activity affects the professional status. The final results show that also other factors are significantly correlated with the online activity and participation, and their importance may vary in different social contexts.

In many contexts, **creativity and innovation** are pursued as major values. However, creative ideas rarely come from individuals alone; instead they often come from teams and groups. Also groups formed through social media play a similar role, as they foster innovation, by improving collective thinking [35]. The role of group structures and dynamics in stimulating and spreading innovation have long been notable subjects of social network analysis and organizational studies. The fit between the structure and task of the group greatly influence groupware performance, with cognitive capabilities also playing an important role, in terms of perception, attention and memory [36]; in fact, an individual's skills can be pushed to their limits by ambitious collaborative tasks. In addition to the number of collaborators, also measuring the quality of collaboration is important [37], as there are significant differences in the timing and frequency of participation and the value of contributed ideas, among various segments of collaborators. Eventually, the study of innovation in groupware scenarios requires the integration of psychological, sociological and organizational studies, for considering an individual's abilities and limitations, social interactions, groupware structures and dynamics, motivation, communication and mediated human interactions by means of various artifacts.

5. Drawbacks and Obstacles to Participation

In contraposition with the various motivations which may foster users' participation in Online Social Networks, there are many resistances and oppositions coming from firms, organizations and individuals' behaviours. In fact, online relations largely differ from face-to-face acquaintances, since Computer-Mediated Communication (CMC) creates its own communication patterns and rules, alongside new and insidious abusive behaviours. In addition to targeting and harming a single user or a group, the emerging result of such behaviours may affect whole organizations and societies. Among these **anti-social** behaviours, like misinformation, fake news and hate speech, many cases are surging as global phenomena and threats, as demonstrated by the recent role of QAnon in the storm of U.S. Capitol, the no-vax movement, the online diffusion of suprematist theories and conspiracies, the alleged manipulation of public opinion during elections and polls, etc.

Misinformation is becoming very relevant in Online Social Networks as their users share a very large amount of data and news, often without the ability or attention required to verify their reliability and credibility. In fact, this kind of verification requires a user to perform many steps, i.e., to search for the source of an image and in general looking for original information sources on the web, to check the profiles of users who post debatable and particular news, etc. As a consequence, a large part of users essentially believe in and share most information they receive, assuming its trustworthiness without any further control. For this reason, one of the most actual and important challenges for researchers is to develop knowledge and models for the automatic discrimination of fake news from authentic information [38,39]. In fact, associating news with their level of trustworthiness has become one of the most important challenges in large online communities, both for users and administrators, especially in the case of social and health issues, or during crises, election and polls. For example, the European Union is addressing those issues in its Digital Services Act and Digital Markets Act, with the aim to "create a safer and more

open digital space” (<https://ec.europa.eu/digital-single-market/en/digital-services-act-package>, accessed on 17 March 2021).

Together with the emergence of CMC, also the phenomenon of online **trolls** has taken form as a particularly relevant problem in new online communities. Morrissey [40] suggests that “*trolling is an utterer producing an intentionally false or incorrect utterance with high-order intention to elicit from recipient a particular response, generally negative or violent*”. With respect to other anti-social online behaviours, like spamming, trolling is more devious. In fact, trolls often pretend to share common interests and pose as legitimate participants of the group [41]. However, their ultimate aim is to lead the conversation toward other arguments or pointless discussion [42]. Trolls may damage an online community in many ways: interrupting discussions, diffusing misinformation and in general undermining the trust among community members. Trolling is a well known and infamous phenomenon of public forums, blogs and social platforms. But it may also affect private platforms, deployed inside firms and organizations, or it may exploit the social features of the online private systems of a company. The various features and the nature of different online social networks may favour the trolling phenomenon, or discourage it, in particular depending on the degree of identity that users reveal. If users are protected by strong anonymity or nonreversible pseudonymity, some of them will engage in anti-social behaviours, which are considered unacceptable in typical face-to-face discussions [40]. Mature communities may be able to ignore provocations, which is one of the most effective solutions to the problem of trolling. But also various features of the platforms, like blacklisting and flagging, could help keeping the phenomenon under control. A promising approach is the automatic detection of trolls, which may be used for excluding abusing users or at least to advise them to moderate their own mood and behaviours. Various automatic classifiers are described in the scientific literature, adopting different approaches and analyzing different user features: polarity of messages [43], frequency of generated answers [44], reliability and reputation [45], user profiles [46], or even the combination of multiple kinds of analyses, in a holistic approach [47,48].

In many cases, the adoption of online social networks may be hindered by very practical and cost-based issues, which are sometimes referred to as the **Digital Divide**. In [49], the very critical issue of access to telehealth is addressed, especially as many hospital systems adopted it to implement the social distancing required in the outbreak of COVID-19. The public health crisis has exposed the problem of diminished accessibility to technology as a critical issue. It has been found that those whose access was impeded were the most vulnerable to poor health outcomes. In the same scenario, in [50] also education is found as a factor contributing to digital exclusion. Though emerging as a critical problem during COVID-19 crisis, the Digital Divide has long been a limitation for accessing online services, including health and education [51], but also for transitioning to remote working [52].

In the business context, adoption may be hindered by other users’ abusive behaviour, but it may also be restrained by issues related to organizational risks and costs. In fact, a study published by AT&T [53] lists three main groups of challenges, as possible causes for a limited adoption of internal social media by businesses: (i) organizational costs, (ii) risks of capital loss, and (iii) technical challenges.

Probably the main resistance to the adoption of social networks inside businesses is related to the perceived **organizational costs**. In fact, networking time is mostly regarded as a cost inefficient activity and employees are often unable to manage their working schedule with the necessary freedom. Instead, benefits associated with social networking at the business level are mostly indirect and it’s usually difficult to quantify them. An associated problem is that social networks need to reach a critical mass to be functional, and thus it is necessary to define plans for stimulating initial participation. The perception of organizational costs negatively influences the initial phase, in which executives, managers and cadres may not dedicate the necessary resources to facilitate the transition. On the other hand, regular employees often find little value in contributing to some new platform.

Moreover, it's critical that all these organizational issues are faced with timeliness, since social environments evolve very quickly, reaching a large user base and consolidating behaviours in a matter of months. Such developments need to be handled with competence, to avoid the diffusion of bad practices, which may drive users to lose the initial possible enthusiasm and completely abandon the platform.

Resistance to adoption of social media inside businesses may also be motivated by the risk of **loss of capital**. This kind of risk regards all forms of capital, including financial resources, intellectual properties, human and social capital. For example, employees and members disclose private information through some adopted online social platform. Social mechanisms, like gossiping and word of mouth may drive the rapid and viral diffusion of sensible and protected content, or any form of intellectual capital, reaching also the outside world. Another concrete risk is the increased exposure of employees' profiles, which may ease the mobility of key employees and managers, increasing the overall turnover rate.

Finally, there are important additional **technical costs**, required for operating a social media platform and its underlying more complex and open infrastructure. Typical social media applications, which usually allow users to share videos and other forms of rich content, raise the requirements for bandwidth, storage and computational power. New challenges come also from the need to ensure the interoperability of different information systems, required by the increased and differentiated use of social media. Additional costs come from increased security risks and harder requirements to respect, for ensuring secure communications and usage, with regards to authentication, authorization, integrity, confidentiality, non-repudiation. This is due to the need to partially open the enterprise intranet to external networks for enabling social collaboration [54], which also leads to additional risks posed by malicious users, ingenuous behaviours, diffusion of various forms of malware.

The list of challenges highlighted in the AT&T study [53] refers to business environments, specifically. However, similar issues emerge also in other contexts. In [55], the issues emerging in **government agencies** are discussed. Among one of the main problems, the study highlights the unproductive time spent by employees on social networks; it is one of the organizational costs that is common also in the business environment. In fact, it is a problem which is not strictly related with social technologies, but instead it is associated with multiple kinds of networks and systems, including mobile phones and emails. Thus, this kind of problem is generally related to the organization and management functioning, more than technologies. Other important issues are due to possible insecure users' browsing habits, carrying risks of introducing malware and spyware into the agency. Since they can open organizations to severe attacks to very sensible data and assets, these risks require large efforts to be mitigated and effectively contrasted. Finally, also government agencies have to face the problem of increased requirements about bandwidth capacity and other technological resources. The study suggests to deploy enough additional resources, allowing at least an effective rich-content communication with the public by selected agency members. For achieving successful internal adoption of social platforms, both businesses and agencies need to define a transition strategy, thus avoiding the uncontrolled adoption of different technical solutions and processes in different groups and instead leading to the formal incorporation into existing information systems. In addition to managers and IT professionals, one of the main roles can be played by knowledge management professionals, who may act as **social networking architects**. Both the main knowledge flow and the pattern of connections in the social network have to be taken into account. Thus, social network analysis can provide managers with useful insights for reshaping the organizational structure, orienting it to the achievement of its business goals on the basis of its concrete functioning. According to [56], the transition has to be designed at three main levels: (i) change the organograms to facilitate the flow of knowledge inside the organization, (ii) develop a knowledge network as evidence onto which actions can be based, instead of using only intuition, and (iii) highlight the individuals' role for solving local problems, for example eliminating knowledge bottlenecks determined by factual gatekeepers. At

all these levels (structural/organizational, knowledge-network, individual/leadership), the transition can be planned exploiting the results provided by Social Network Analysis. They also can be important for dealing with common business tasks, especially improving the flow of knowledge, retaining and flanking people with vital knowledge, increasing innovation, creating and developing distributed teams. In [57] the leaders' role and profile in virtual teams are discussed, following the same lines. The work states that such team leaders especially need abilities to build relationships and to defuse frustrations, to create an effective virtual work environment for remote participants. Thus, in addition to the usual technical and leadership capacities they also need particular communication skills, for embracing diversity, motivating the team members, establishing trust and fostering the team spirit. Another skill, which is also important, is the good knowledge of video conferencing software and other CSCW tools, for operating them and allowing everyone to participate in a more fluid collaboration environment.

6. Social Media and Feral Systems

In [58–62] there are some discussions about the impact that social media have had in the world of work: in particular, their daily use by users and workers has been the basis of the birth of **feral systems** [63] which some companies have then adopted within their processes. If social media tools have changed the way we live our free time, they are changing the way we work. Tools such as Twitter, Facebook, WhatsApp are used in various ways to share knowledge, create work groups, organize an agenda. In some cases, social networking platforms are used without corporate blessing, maintaining their status as feral systems [58]. Because they often covertly replicate the data and functionality of formal IS, they are known as “Shadow IT” and can cause data security and consistency issues [59]. In recent years this fact has also created interest in the management of companies and the classic well-structured Information Systems (IS) has been accompanied by the use of external social tools, especially in those areas where agility and speed in making decisions are important prerogatives. In [60] the authors show a positive relationship between social media usage and IT employee agility in organizations. They are sometimes referred to as Enterprise Social Media (ESM). ESM tools, such as DingTalk, Slack, Microsoft Teams, Trello, and Yammer, are widely adopted by companies to support employee communication, collaboration, and knowledge sharing [61]. Also in small and medium-sized companies not belonging to the ICT sector, social media has entered into the system through the adoption of them by the younger employees (digital employees) making it more social and more technical. In an interesting and recent article [64] the results of previous research on Chinese small and medium-sized companies are reported. This kind of companies are often characterized by the absence of a structured organization, IS professionals are rarely numerous, and, so, many *ad-hoc* solutions have been implemented by the employees with the help of social platforms. For example [65] reports the case of a comparison between two different generations of workers and how digital native employees in the Chinese operations of a global hotel chain subvert a restrictive corporate policy regarding the IS, guaranteeing access to the resources they insist on needing. Again, In this context, social media of common use (and not developed *ad-hoc*) have spreaded out, making it urgent for companies to redefine the information and business security policies.

In general, the use of social media has changed our societies in all their aspects and they are really widely used in the creation of Socio-Technical Systems that overcome the barriers imposed by independent systems, be they governments or companies. Widely used to collaborate and interact, social media are also used for facilitating Knowledge Sharing (KS). This trend has attracted significant attention from the professional and academic fields as indicated in [62].

In education many social media tools and platforms are used by students to build small *ad-hoc* communities or to obtain transversal skills. Often these tools are preferred to the official ones both because people feel free in their use and because these technologies are an integral part of their communities and life. Young people overcome the constraints

imposed by traditional education platforms proposed by the various schools independently of each other and in this way a sort of feral IS is created in which sharing knowledge and acquiring information from more than one source. This is precisely one of the results reported in [66], in which two thirds of the university students prefer independent social media tools to official platforms as regards knowledge sharing technologies. According to the results obtained by this research, students prefer a variety of independent resources instead of a single one in order to reach knowledge. In addition, it can be seen that a majority of students used note-taking applications and shared their notes via smart phones. In [67], the author argues on how the integration of social media in education can enhance students' learning (e.g., active learning) and teachers' informal learning (e.g., resource exchange, community building). Moreover, social media can create opportunities to innovate educational research methods and knowledge discovery [68]. The article in [69] reports a research concerning the correlation about the use of social media and the professional development in higher education. The results evidence that there are some open challenges in sustaining faculty participation and engagement in the social media space. For example, collaborative, repository features, such as the Twitter hashtag, serve to develop a rich body of knowledge, but it needs apposite applications to organize them and promote faculty participation in specialized contexts. The study in [70] discusses the potential undesirable effects of the use of social networks in higher education. While formal, traditional pedagogical practices are established, the use of social media has the potential to enhance student participation but educational faculty has still to determine if it provides better learning outcomes. Institutional guidelines in some cases are barriers; some higher education institutions provide in-depth guidance while others suggest stronger cautionary practices to use protected and accepted university learning platforms. It is worth remembering how social media have played a vital role in promoting education during the Covid-19 pandemic. In this case, the use of social media spontaneously and ad-hoc for each context or study group has allowed teachers to at least partially make up for the human processes and relationships that usually occur in face-to-face activities. For example, In [71] the authors discuss the help that social media platforms have given and can give in mitigating the unique educational challenges posed by the Covid-19 pandemic, where the sudden advent of containment measures requires educational institutions of all sizes to adopt eLearning as the only option for sustainable education. This review shows that social media can complement traditional tools such as learning management systems by helping students in achieving pedagogical goals through the creation of contextual learning outcomes. In particular, they enhance meaningful student engagement and help to bridge the gap between knowledge and competence in individual or group work. Moreover, in the era of the pandemic, social media is also important because its availability and ubiquitous use among students and teachers make the connections among them and the institutions easier and immediate.

Even in a very particular context such as that of healthcare, the spontaneous adoption of social media sets new goals in the treatment of diseases, always putting in place new processes of human aggregation and new problems of safety and information and reliability of the same. In most healthcare systems, patient data is stored without standardization of clinical terms. Additionally, a hospital hosts particularly complicated processes that often cannot be fully documented. Hence, this is an ideal environment where employees (clinicians) decide to build the solution by themselves and thus give birth to feral information systems [72]. In this context, social media could have positive impacts as analyzed in [73,74].

Finally, literature reports cases in which the social media expand the public sphere of citizens dwelling on the fact that social networks act on two important and complementary fronts: the emotional/psychological front and the dynamic/social one. Platforms such as Facebook, Twitter, Instagram, if used at their best, are able to unite the emotional drives of individuals and focus attention on the problem, generating new feelings such as collective indignation. Also in this context commonly used tools have been spontaneously adopted

from below and pose new challenges in the interaction between people, in the aggregation processes and in the definition of new professional figures and information security and reliability issues. [75] reports a round-table discussion (entitled “Space of Flows and Space of Places in Networked Social Movements”) on new forms of social movements and protests that are erupting across the world since the diffusion (and with the help) of social media. Recently, in [76] the authors discuss that the techno-social development led to the creativity of citizens forming community networks through the use of the Internet and social media and conducting autonomous conversations in the public sphere. A famous example is that on climate change, where millions around the world joined together to voice concerns about its impending irreversible negative consequences, coordinating effectively via social [77].

7. Social Media and Firms

Structure and firms have now adopted the use of social media within their business processes. The enterprise social media (ESM) technology has increasingly penetrated in firms, and organizations have been strategically deploying such technology to support the communication and collaboration of their employees. However, the efficient use of the ESM technology in the workplace, that is if and how it allows individuals to respond to unexpected changes efficiently and quickly, remains a challenge for organizations and business leaders. Using a sample of Chinese employees, the study described in [78] investigates how ESM usage improves employee agility through meta-knowledge. Results of the paper confirm that organizations can improve the meta-knowledge of employees through investment in the ESM technology and that ESM usage is significantly related to individual agility via meta-knowledge.

A recent study [79] investigated the way in which employees are using social media as a means to compensate for the shortcomings of information technology and the effects of these alternatives on the strength of Human Resources (HR) communication process in large UK organizations. In most cases, the LinkedIn platform is used to adjust CV and cover letters for each position and, on the other hand, there is the use of this platform to “get better candidates” even if this goes against those prescribed by the organization. In all three organisations, employees were aware that their interactions with technology deviate from sanctioned paths, however, they believed that these deviations are benefitting the organisation as a whole. The article also compares the different response given by the three organizations: the first has changed some of its rules and procedures to accommodate social media; the second provides additional training to encourage employees to follow the prescribed procedures, but “turns a blind eye” to this alternative; the third solution institutionalized the practice. In all three cases, therefore, the use of social media was de-facto accepted. Two of the organizations report seeking ad-hoc solutions and sharing knowledge on social media. These organizations demonstrate organizational learning cases and show how organizational routines are changing in response to alternative solutions.

Companies are finding it increasingly important to leverage social media to facilitate knowledge exchange, get valuable feedback and improve innovations to meet emerging markets. In the studies proposed in [80] conducted on 211 manufacturing companies, it was seen that using social media without integrating other key factors does not add value to green product innovation (GPI). Instead, it has been shown that it is important to share knowledge through social media within the company and with suppliers on these issues, for the generation of ideas to improve products to remain competitive on the market.

In [81] the authors aim to demonstrate that the relationship between virtuality at work and social capital is partially mediated by the use of social media. In fact, network ties generate social capital in the workplace when employees interact with each other, share their content and information, process and comment on the content of others. The study was conducted on working students in the Western USA where Facebook, Twitter, Pinterest, Instagram and LinkedIn are very popular social media platforms. The participants worked in the different sectors: education, retail and sales, food industry and hospitality. It is

possible to argue that greater virtuality at work had a significant and positive direct effect of social media use at work, suggesting that virtuality at work may potentially contribute to the use of such computer-mediated tools. But the result of the study report that virtual work processes alone may not by default encourage relational benefits such as trust or network ties, and therefore, not support social capital among virtual workers: an investment into building network ties (via social media or other tools) alone may not bring the same benefits as an investment into social capital formation related to shared vision and trust in the company.

The study reported in [82] analyzes the role of social media in increasing human and social capital in companies and how this ultimately improves their performance. To achieve this the authors identified 24 published practitioner reports by independent consultancies or journals. The results show evidence that the use of social media has improved interactions with customers, obtained more involved and informed staff which led to the optimization of business processes with a reduction in internal costs. The study also found that these goals were better achieved than traditional communication tools or knowledge management systems.

The study in [83] documents how social media applications can play an active role during change implementation processes. It is conducted in the context of both public and private organizations in the field of insurance companies. The results show that change recipients find it easier to express their views in both closed groups on Facebook and social groups on WhatsApp. Interactive communication amongst organizational change stakeholders can decrease the level of uncertainty and ambiguity during change implementation processes. Therefore, the role of management is to specify the boundaries of organizational knowledge sharing by ensuring that it does not negatively influence employee empowerment, socialization and informal communication processes. The authors also argue that the balance between knowledge sharing and knowledge protection has become essential, and the role of participatory management is critical and important in dynamic business processes.

From the perspective of open innovation theory, companies can benefit from internal and external collaboration (social media, internal blogs and Web 2.0/3.0). The research reported in [84] shows the results of a quantitative study conducted within a sample of ICT companies located in Tunisia through informal interviews via LinkedIn with various executives of Tunisian companies. The results underline the importance of the use of social media in the promotion of innovation actions and in the creation and strengthening of interactions and links among users. The use of these tools creates the possibility to spontaneously communicate with others in order to share ideas and improve problem solving. Social media thus become tools that the staff should promote to overcome the dynamics deriving from belonging to different areas of the company and those imposed by the typical hierarchical structure.

An interesting result is shown in [85] which shows the different approach to social tools of large companies compared to medium and small realities. This study examined the effect of technology-enabled social networks on knowledge management processes in Middle Eastern audit and consulting firms. An empirical study was conducted in which auditors from local and multinational auditing and consulting firms participated in a structured survey. All experts agreed that the use of social networks supports the acquisition and creation of knowledge, but with more conviction those belonging to multinational companies. This is probably due to the fact that multinational companies have their branches located in different countries of the world and experts working in multinational auditing and consulting companies are given the opportunity to receive specific training on new technology platforms. Large companies also have the ability to develop a proprietary social platform. Deloitte, for example, has called such a system the “knowledge exchange platform”, which is accessible to all members of the company for acquiring or sharing new knowledge.

In [86] the authors focus on the relevance of social media tools as key tools for addressing complexity, enabling companies to establish relationships with key market players such as customers, suppliers and business partners. As these agents have different roles and objectives, it can be argued that being in contact with all these heterogeneous agents will improve business connectivity, helping businesses to be more open to the market. The authors demonstrate this relationship through theoretical development and its empirical verification of the relationship between the use of social media and organizational performance, analyzing a sample of 201 technology companies in Spain. The study described in [87] research reveals that many organizations are using social media in B2B supply chain operations. This trend appears to be on the rise, even as social media offers an openness of business data that does not exist in traditional systems and this could raise safety concerns. The authors have conducted a survey to determine the level of social media usage in B2B supply chain settings. Respondents work in both medium-sized and small companies. 60% of them have said their organizations use social media in the B2B supply chain in a strong way. Additionally, people involved in B2B supply chain operations report that social media can help with supply chain performance and can improve relationships with supply chain partners. They suggest that the open challenges are not too great and that technology cost, while needing to be considered, is not prohibitive. Social media changes the way we build brands and it is possible to question whether employees can support their companies' activities on social media. The document described in [88] reports a study on the relationship among the power of the corporate brand and the contents related to the company by employees. Although the study was performed in academia and perhaps other fields could yield slightly different results, it reveals that, today, employees are also as critical players in the brand management process as brand marketers or consumers.

Studies on social media have been done in the belief that by making it easy and efficient to connect with virtually any person in an organization, these tools can help rewire employees' social networks so that they are less marked by homophilia [89]. However, the study highlights that, despite these tools offer solutions for open and distributed communications, the social networks that emerge can strengthen social stratification in some dimensions. In order to obtain less stratified networks, managerial intervention may be necessary. For example, the use of recommendation systems in company social media can encourage the creation of heterogeneous groups.

Finally, the impact of social media on individuals' entrepreneurial entry was also examined. This studies refer to individual entrepreneurs which, by size, do not use the information systems of more structured companies. For example, a research [90] in this field was supported by a sample of adults in China. The study reports that although social media is dominated by weak ties and substantial noisy information (sometimes even false information), the results reveal that people with greater use of social media tend to conduct an entrepreneurial entry. Social media has greatly expanded the ability of individuals connect in a network, by removing geographical, cultural and professional boundaries. This is particularly beneficial for an individual looking for business ideas that may be based on emerging business practices, trends or models in other countries. For example, Jack Ma of Alibaba didn't have to travel to the United States to come across the idea of an online commerce platform, he just observed the Net. Moreover, individuals can use social media to refine and validate their business ideas and secure resources for entrepreneurial launch.

8. Non-Profit Organizations and Agencies

In [91], NGOs for international and local development are analyzed under the aspect of social capital and knowledge management. In particular, these non-profit organizations currently operate on projects in a form that is data-intensive, where the exchange of information and knowledge is a key factor. This sector can be regarded as an important industry, which aggregates over 19 million paid workers, in addition to countless volunteers. The objective of the study is to derive a model for optimizing the integration of such organizations and make their management more effective. The study is based on

a survey answered by 215 NGOs operating in the area of European Union and Western Balkans, with projects for international development and cooperation targeting groups of marginalized people. The social capital of these organizations is analyzed according to four aspects: structural, relational, cognitive and nodal [26,92]. The knowledge management is studied on the basis of four key knowledge management stages: creation/innovation, acquisition/collection, dissemination/share and usage/application. Though many of these processes happen through information systems and some forms of online collaboration, the study does not underline their technical features and does not discuss their best integration into organizational processes. Consequently, results of this kind of integration are not available.

In [93] a social media (Facebook) is used as a support for a chronic disease. This group is dynamically analyzed by combining Social Network Analysis (SNA) and Emotion Detection techniques to evaluate the patients' emotional state and how this is influenced by different social network factors, such as interactions and friendships in the group. The research results indicate a possibly positive role of building stable social relations inside the group of support, although this group is formed outside of a hospital logic.

NNLRank [94] is a recommender system for supporting new developers in their selection of an open source project to join. Recommendations are based on the project features and the developer's past experiences. The system is evaluated with 2044 onboarding decisions on GitHub, comparing various learning models. The proposed problem is important, as the onboarding phase is often very tedious. In fact, new developers wanting to contribute code have to understand the systems, its norms and styles. Their committed code is then reviewed by core project members, matching it with the project aims and standards. Especially for the first commits, the whole process can be long, frustrating and very inefficient both for new and core developers. The study results show that onboarding opportunities are larger at the early phases of a project, or if the project has many commits and company colleagues; engagement is more likely to succeed in the cases where developers previously joined other projects with the same owner or they have experience with the programming languages of the project.

In [95], conversational bots are proposed as a tool for supporting social and technical aspects of software development. In fact, onboarding of new members in open source software projects is a difficult task, which can be made more effective through mentorship. The bot is designed to leverage available tools, including Rasa as an open source solution to perform natural language understanding, GitHub APIs, to gather information about projects and users, and Stack Exchange APIs, to access questions, answers, and comments of Stack Overflow etc. Apparently, the development of the bot is at an early stage.

In [96], authors present a theoretical model about developers' successful participation in open source projects. The model relates the developers' intrinsic motivations, extrinsic motivations, level of participation, and performance. The model is evaluated using both surveys and archival data about Apache projects. Motivations are not independent, instead they are found to be related in complex ways. Different motivations affect participation in different ways. For example, status motivations are improved by being paid for the open source activities, while use-values motivations are negatively affected. In general, there has been no evidence of direct negative impact of extrinsic motivations over intrinsic ones. Paid developers show higher contribution levels, in association with status motivations. Instead, use-value motivations lead to lower contribution levels. Intrinsic motivations are improved by status motivations, but those intrinsic motivations do not affect the contribution level significantly. Results also show that a developer's previous performance rankings enhance his own future status motivations.

Traditionally Open Source Software projects have grown around a community of enthusiasts since their inception. More recently, however, another paradigm has emerged. In fact, in many cases open source projects are created by organizations, which spinout internally developed code. The lifecycles and dynamics of these different types of projects are compared in [97]. In the case when a community is built in parallel with the software,

the project benefits from a shared view of the architecture, formats, norms and processes, together with a manifest commitment of individuals. However, this parallel development has its own drawbacks, as it may require a long starting phase to overcome initial uncertainty over project direction and its feasibility, both as software and as community. Moreover, the widespread adoption of the open source development model exacerbates the competition for reaching the required critical mass of quality contributors. Finally, the interest of commercial entrants for this kind of projects creates friction between the interests of firm and community. Instead, projects developed in-house and then translated to open source have the initial advantage of a more clearly established architecture and viability. Moreover, their maturity and recognition, together with the sponsor's support for marketing, can help attract talented contributors. However, the presence of previous code "owners" may discourage new contributors, who may find it harder to leave their own mark on some portions of the project, which is an important motivation to participate. Eventually, also modularity in the source code is important for encouraging new skilled developers to contribute autonomously. Instead, participation would be discouraged if the project is perceived as a simple transfer of maintenance duties to an open source community, or its governance structure is dominated by a single sponsor, or a group of sponsors. As an example, in [97] the authors describe the case of an healthcare information systems initially developed for the U.S. Department of Veterans Affairs. In the development of this project, one of the main challenges was the collaboration among the sponsor's developers and the larger community, to be built. From the technical point of view, this kind of collaboration for developing open source software require three main kinds of platforms: (i) a repository for sharing the code, (ii) a tracking systems for monitoring the issues, including bugs, updates and enhancements, and (iii) discussion groups, i.e., mailing list, chat, etc. As some measures of success for this kind of projects, from the sponsor's point of view, the authors of the study suggest: (i) creation of a larger market share and user base for the software, creating a strong ecosystem; (ii) participation of external developers and reallocation of internal resources to other projects; (iii) transformation of the software into a public good, especially if the sponsor is a government agency or a nonprofit organization. The balance of these goals depends entirely on the sponsor's strategy. However, the study does not provide clear measures for the example project.

Similarly, [98] analyzes the role of sponsored developers in open source projects. The study adopts the concept and perspective of social capital, arguing that the influence of an individual in a community depends largely on his/her position in the social network. The case study is the community of developers working on the Linux kernel, which is analyzed from various aspects: structural capital, relational capital, cognitive capital, and finally sponsorship. The basic assumption of this kind of social capital analysis is that the position in the social network and the strength of social ties are valuable assets, since they can provide advantageous access to information and ultimately drive the acquisition of new value.

9. Smart Cities and E-Governments

Designing e-services around social media platforms can be a choice to go towards a widespread use among citizens and a way to reduce costs. Indeed, a smart city application or service that is built only on the merit of technologies without paying attention to people would risk disconnecting the service from its users. In this section, we will present some of the most interesting cases where smart cities and e-government services are enhanced using social media platforms. In particular, we follow these main guidelines: adoption from below by citizens, cost reducing for the organization, smart solutions to manage urbanization consequences.

One of the most important factors when considering the adoption of a solution by the end-users is their engagement. In [99], the authors present a guideline to develop social technical systems for e-government based on the distinction of traditional vs transactional

forms of citizen interactions in the smart city. Transactions are divided in four categories of engagement [100]:

- Type: unrequested citizen to government transaction (for example an email)
- Tweet: third-party mediated connection between citizen and government
- Tap: Requested contribution from government to citizens (e.g., survey or webform) with specific boundaries of request
- Pass: Citizen provide feedback and information to government via their presence within an instrumented landscape (sensors or geo-located social media data)

Each of these forms of transaction represents a directionality and depth of citizen-government engagement. In this paper we will analyze the impact of social media platforms, thus we will take into account only the “Tweet” and “Pass” categories.

In order to tackle the intelligence aspect of smart cities, one of the key functions required pertains to the continuous monitoring of assets. This function implies to track people, events and phenomena and use their data as intelligence for the streamlining of the operation of the city and to improve its performance. Conventional methods to collect such information typically relies on dedicated sensing infrastructures (e.g., surveillance cameras and wireless sensor networks), which require high deployment and maintenance costs [101]. On the opposite, social media platforms enable the so-called mobile crowd-sensing, where users equipped with sensor-enabled phones collaborate to sense data related to phenomena of interest, for example traffic conditions, accidents or disaster occurrence. In [102], the authors have exploited Twitter data to detect spatio-temporal events in London. They have collected three million tweets from citizens, using geocoding to locate data sources and make additional analysis with machine learning techniques. In particular, they have filtered out non-related traffic tweets with a classification model and they have analyzed the distribution of geo-located tweets over the hours. Finally, they show that their architecture is able to detect events occurring in London in real-time, even when they are not planned. In [103], the authors made a step further implementing a social media based framework for incidents and disaster monitoring. Indeed, one of the main challenges facing emergency responders is the lack of situational awareness about the incidents, such as: the exact location, the scale of the disaster, the environmental conditions and the severity level of injuries. Without this key information, it becomes difficult to properly assess the situation and bring appropriate help to the involved citizens. For instance, the underestimation of injuries and their severity may lead to the lack of proper medical equipment and thus delay in the assistance. Crowdsensing with social media can really help in such situations because users’ feeds can provide rapidly valuable information if data are automatically collected and analyzed to make disaster reports. Moreover, people are unaware of their vital contribution, thus, they join this application by only sharing contents on social media. In particular, in [103] Natural Language Processing (NLP) techniques are used to extract information from unstructured textual data with a document classification task. Arabic social media feeds relevant to certain topics are automatically extracted, processed and analyzed in order to generate real-time city intelligence reports about events such as: event type, the event scope, the impact level, environmental conditions (smoke level and temperature), number of involved people, etc. In [104], the authors demonstrate how user-generated data can be analyzed to generate new useful information for developing citizen-centered smart services and policy making. They have further analyzed the use of social media feeds to support urban planning in the City of Alicante especially for sport infrastructure. In particular, their solution helps the local government to design better infrastructures based on where and when they are used by people. Twitter is exploited due to the large amount of data produced on a daily basis. They are able to depict urban boundaries, to analyze the relationships between factors affecting human outdoor activities in the city and to obtain socio-spatial relationships. Finally, they present their findings and some proposals for future works in this direction: sport accessibility in a modern city is in general low as a consequence of the urbanization, however, once the most visited places are detected, the local governments can improve their accessibility by installing public

furniture, street lamps or traffic lights in the sidewalks or by making the sidewalks broader by reducing the space for vehicles. Crowd-sensing through social media feeds covers mostly examples of “Pass” interactions, where practically the citizen is unaware of his contribution but his information is fundamental for different contexts, as discussed above.

On the other hand, e-government services tend to exploit mostly bidirectional communication with the government using third-party applications. Indeed, the possibility of using tools that are also adopted for other personal reasons represent a key-factor for the adoption from below by the users. In [105] the authors presented the results over 119 Italian municipalities related to the engagement of using social media tools for e-services. Another example of the use of social media for municipal public administration is the Italian IRIS online platform where citizens can report urban maintenance problems and expect an answer from the government that is currently adopted in Venice [106]. However, in this case citizens’ engagement is not evaluated and a main limitation is represented by the use of an ad-hoc platform. Indeed a more interesting case is presented in [107], where the citizens can report issues and problems by using Whatsapp, Telegram and Facebook bots that automatically understand the context of the maintenance requests and sending them directly to the appropriate municipal office.

10. Discussion and Conclusions

Table 1 presents a comparison among the works analyzed in the previous sections. In particular, the research works are classified according to different criteria:

- **Scope:** scope of the Socio-Technical System, i.e., feral systems [63], firms, nonprofit organizations and agencies, smart cities and e-government;
- **SNA:** if the research work is based on *Social Network Analysis* techniques, or not;
- **SC:** if the research work is based on *Social Capital* theories and models, or not;
- **Spo.:** if the social media platform has been initially adopted spontaneously, from below, instead of being mandated and sanctioned in a designed process;
- **Mot.:** if the research work takes into account the users’ motivations for participation into the social media platform;
- **Cost:** if the research work takes into account the issues and costs which may hinder the adoption of the social media platform;
- **Fac.:** if the adoption process and the transition phase are analyzed, eventually describing the facilitators’ role;
- **Pop.:** if the analyzed system is based on a popular social media platform, instead of an ad-hoc social platform;
- **Open:** if the analyzed system is based on open protocols and/or open source software, instead of proprietary ones;
- **Res.:** if the research work presents a methodology for the evaluation of the results of social media adoption, or not.

The results presented in Table 1 show a very mixed picture. In fact, many research works deal with Socio-Technical Systems and discuss the role of social media platforms in this context. However, in many early real cases, the adoption has provided subpar results [58]. Our analysis shows that few works adopt a complete methodological approach, for dealing with the most frequent issues hindering the integration.

- Social Network Analysis and Social Capital models are rarely applied to a real process of integration of social media platforms into Socio-Technical Systems. Indeed, few works systematically exploit those kinds of analyses [58,81,91,97].
- A positive note is represented by the fact that a number of research works include at least a basic intuitive evaluation of the users’ motivations and the integration costs, which may drive the concrete adoption of the designed solution [61,62,81,84,97,106].
- It is also positive that several works present or propose an evaluation of the results of the transition process, after initially considering both possible new benefits and problems for the whole organization, e.g. [60,61,77,79,81,84,85].

Table 1. Comparison among the analyzed works.

Article	Scope	SNA	SC	Spo.	Mot.	Cost	Fac.	Pop.	Open	Res.
[58]	Feral	✓	✓	✓	✓	✓	✓	✓	✓	
[59]	Feral			✓	✓	✓	✓	✓		
[60]	Feral: KM			✓	✓	✓	✓	✓	✓	✓
[61]	Feral: KM	✓			✓	✓	✓	✓		✓
[62]	Feral: KM	✓			✓	✓	✓	✓		
[66]	Feral: Edu.			✓	✓			✓	✓	✓
[68]	Feral: Edu.	✓		✓	✓	✓	✓	✓	✓	
[69]	Feral: Edu.	✓		✓		✓		✓		
[70]	Feral: Edu.			✓	✓			✓	✓	
[71]	Feral: Edu.	✓		✓		✓		✓	✓	
[72]	Feral: Health			✓		✓		✓	✓	
[74]	Feral: Health	✓		✓			✓	✓	✓	✓
[73]	Feral: Health			✓		✓	✓	✓		
[76]	Feral: Society	✓		✓			✓			
[75]	Feral: Society	✓		✓			✓			
[77]	Feral: Society			✓	✓	✓	✓	✓	✓	✓
[64]	Feral: KM			✓		✓		✓	✓	✓
[65]	Feral: KM			✓			✓	✓	✓	✓
[79]	Firms: HR		✓	✓	✓	✓	✓	✓	✓	✓
[81]	Firms: HR	✓	✓		✓	✓	✓	✓	✓	✓
[88]	Firms: HR			✓		✓	✓	✓	✓	✓
[89]	Firms: HR	✓				✓	✓		✓	✓
[85]	Firms: HR			✓	✓	✓	✓	✓	✓	✓
[78]	Firms: HR					✓	✓			✓
[80]	Firms: Innov.	✓				✓	✓	✓		✓
[83]	Firms: Innov.	✓				✓	✓	✓	✓	
[84]	Firms: Innov.		✓		✓	✓	✓			✓
[82]	Firms: ESN		✓			✓	✓	✓		
[86]	Firms: ESN	✓				✓	✓	✓		✓
[87]	Firms: ESN			✓		✓	✓	✓	✓	
[90]	Firms: Entrep.			✓		✓		✓		✓
[91]	Nonprofit	✓	✓	✓						
[93]	Nonprofit	✓		✓	✓		✓	✓		✓
[94]	Nonprofit				✓		✓	✓	✓	✓
[95]	Nonprofit				✓		✓	✓	✓	✓
[96]	Nonprofit		✓		✓		✓	✓	✓	✓
[97]	Nonprofit	✓	✓		✓	✓		✓	✓	✓

Table 1. Cont.

Article	Scope	SNA	SC	Spo.	Mot.	Cost	Fac.	Pop.	Open	Res.
[102]	Smart cities		✓	✓	✓	✓		✓		✓
[103]	Smart cities		✓	✓	✓	✓		✓		
[104]	Smart cities		✓	✓	✓	✓		✓		
[105]	E-government		✓	✓	✓	✓				
[106]	E-government		✓		✓	✓				
[107]	E-government		✓	✓	✓	✓		✓		

The daily use of social media by users and workers has initially taken the form of **feral systems**. Nowadays, well-structured companies have incorporated and embraced users' motivations in the design of their "socio-technical" systems. Obviously, this has led to new challenges for companies that have had to revise personnel management and business processes. Also social media has entered into small and medium-sized companies not belonging to the ICT sector and where IT experts are rare: the younger employees (digital employees) are making them more social and more technical. In this context, commonly used social media (and not developed ad-hoc) have become widespread, giving rise to a sort of feral system. This makes it urgent for companies to redefine corporate information and security policies.

Also in the development of our whole society the impact of social media is very important to overcome barriers imposed by different states or organizations. A particular context in which users spontaneously adopt commonly used social platforms to share knowledge and professional development is the field of education. In this case, first in the universities and then gradually in the higher schools, each institution has defined its own tools for sharing knowledge and official profiles on the most common platforms. However, the spontaneous and free use of these platforms makes it possible to overcome institutional barriers by identifying new interaction processes and the possibility of finding channels with updated information in a more agile and faster way than the traditional one.

In **firms** scenarios, most companies have now adapted the use of social media into their business processes, and business experts have coined the term **enterprise social media** (ESM) for them. In general, the literature refers both to the use of proprietary technology and commonly used platforms. Only a few recent studies focus on the spontaneous adoption of these tools, now taking their use for granted. Almost all the articles proposed have a section relating to costs and challenges that sets out the design of ESM and proposes a methodological section for redesigning business processes and the way employees work and relate to each other. Some studies discuss the possibility of larger companies to intervene in their social platforms to guide relationships and the formation of work communities and so to modify friends' network of employees. It is worth noting that in almost all the proposed literature there is an experimental section in which data from case studies of small, medium and large companies are collected through the use of interviews with both businessmen and simple employees. From these studies it seems that the leading companies in the use of ESM are those of ICT, firstly because of the skills of their employees at all levels, but also because of the business problems, since these tools give the ability to adapt quickly to circumstances.

Among **nonprofit organizations and agencies**, social media are a fundamental tool for collaboration at many levels, especially in the case of organizations operating at the international level. However, such tools are rarely documented and they are mostly adopted spontaneously, without previous planning. In fact, few scientific works are available for analyzing this kind of entities [97]. A notable exception are open source projects, which are participated by programmers and other tech-savvy members. Moreover, many open source projects use well defined tools and platforms (i.e., mailing lists, issue

tracking systems, code repositories, etc.) which guide the definition of clear processes. In these cases, besides a community of enthusiasts, there is often the presence of commercial businesses, which are interested in the best development of the whole open source project, including the best results of the integration of social media platforms.

Also in **smart cities and e-government** scenarios, although many organizations are adopting social media as a data source or as intermediary of their communications with citizens, several problems are still open and should be discussed. Social media platforms have various data quality issues such as accuracy, precision, completeness and representativeness [108,109]. Indeed, most of the platforms tend to attract certain population groups or support mostly the sharing of a particular content, making them limited in data representation. The open problem can be summarized as the intrinsic biased sampling of these platforms. If decision making is based on social media feeds, it is crucial to understand the dimension of this bias. In [110] an extensive discussion about this bias is presented in some cases in China. We can have a demographic bias, due to the fact that older people use less social media, so their needs and opinion would be underrepresented. Spatial biases can be possible in a way that events can result to happen mostly where most of the younger people usually live or spend their free-time. Finally some topics are less discussed on Social media than others. Different solutions to these limits are possible and are currently discussed by researchers. Although it is out of the scope of this paper, we can suggest that statistical adjustments for this bias have to be carefully taken in consideration when a socio technical system is designed or implemented using social media platforms.

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