

# Online Social Network Viability: Misinformation Management Based on Service and Systems Theories

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## Abstract

This paper provides a practical example of how service and systems theories can be successfully integrated to develop a comprehensive analysis and theorization of solutions for a specific issue, that is, misinformation management in online social network sites (OSNs). A literature review and elaboration of different theories (service science, service-dominant logic, viable systems approach) and approaches (collective intelligence and collective knowledge systems, group decision making) specifically related to OSNs is developed and presented in the form of propositions and constructs. It results that the issue of misinformation in OSNs can be analyzed as a threat to service (eco) system viability, while technological solutions, engagement and the participation of communities by means of collective knowledge systems should be adopted as strategies to align with relevant supra-systems to survive. The originality of the paper relies on the following: (i) expanding service research analysis horizons to OSNs; (ii) providing a practical example of how Service Science, Service-Dominant Logic and Viable Systems Approach perspectives can be integrated to theorize and practically find ways to re-shape contexts, such as OSN misinformation management; and (iii) presenting a multidisciplinary conceptual model to the OSN literature, based on service systems and service ecosystems, linking theory to practice.

**Keywords:** service system; service ecosystem; viable systems approach; collective intelligence; fake news; information variety

## 1. Introduction

Currently, there are more than 3 billion active users on social media platforms (We Are Social and Hootsuite, 2018), which have become the primary newsfeeds and influencers of opinion formation in individuals (Xiong et al., 2017), rather than only private amusement and communication tools (Wise et al., 2012). Positive examples regard conversations about rights and stories about injustice on social platforms that have emerged as viable forms of networked activism beyond the digital sphere (Lokot, 2018). Nevertheless, since social platform activity has become increasingly intertwined with the events of the offline world (Abou-Moghli and Al-kasasbeh, 2012) and due to the speed and ease with which news can be spread, individuals and organizations have conscious and unconscious ways to spread misinformation, even attacking and smearing others to deceive and manipulate people. A recent hot topic has been fake news propagation (in which fake news involves deliberate misinformation or hoaxes, Connolly et al., 2016), as in the case of the Pope's support for the Trump candidacy during the US election campaign, which was shared on Facebook (Allcott & Gentzkow, 2017). However, non-deliberated misinformation is also very common (rumors, intended as lacking clear evidence and expert opinion on a statement, Nyhan and Reifler, 2010; DiFonzo and Bordia, 2007), particularly with regard to scientific issues (Vraga and Bode, 2017), which can also be simply misunderstood and misreported, as in the case of rumors about diseases (Jin et al., 2013) and ways to treat them.

Misinformation (deliberate or not) undermines serious media coverage, rendering it more difficult to spread significant news stories or truthful information and sometimes causing a wave of negativity and confusion (Halliday in The Guardian, 2017). Misinformation impacts markets, as in cases of financial panic or unjustified

changes in consumers' choices, and it increases stress. Moreover, because falsehoods seem to people to be much more novel than true news, they are diffused significantly more rapidly than truths (Vosoughi et al., 2018). Thus, misinformation corrupts the trustworthiness of social networks of every size (Thai et al., 2016), both as brands and as smaller groups (or communities) that populate them, undermining their viability (Editorial Board in The Washington Post, 2016).

Today, there is a need for rigorous systems to perform effective content verification, with both expert-based and technological ones.

For example, Facebook, after having published a user support guide for recognizing fake news, established a collaboration with control partners. More generally, groups and organizations providing professional independent fact checking have increased dramatically in the last few years, with 150 entities in 2018 (Stencel and Griffin, 2018).

At the same time, researchers and large companies (Levin, 2017) have started to focus their efforts on automatic fake news identification systems (see the Appendix for some examples).

However, even Facebook recently opened up to the option of mobilizing the community to perform human fact checking (Susarla, 2018). This move might be particularly useful for small OSNs, such as those used in companies or built around specific topics (oncology, dermatology, football, healthy food, etc.) or in thematic groups of larger OSNs. Indeed, although automatic solutions should – but currently cannot – be very efficient in cases of deliberate fake news, they seem to be powerless when even experts or scientists have doubts.

A recent report (supported, among others, by the OECD, Koulolias et al., 2018) called for cocreation solutions to combat misinformation, even by creating cross-sectorial teams to spot misinformation, building engagement platforms to attract community members, fostering interactions and enabling individual experiences to emerge (Gouillart & Hallet, 2015).

Thus, new cocreation solutions, which are able to incorporate technically enabling functions and engaging social mechanisms, should be conceptualized, designed and developed. In line with the recent trends in marketing and management cultures, these solutions should be based on service (Vargo and Lusch, 2008); that is, they should consider the basic principles to enable and foster interactions and to successful value cocreation among the parties involved. Service research has previously addressed OSNs, mainly in terms of design (Edvardsson et al., 2011a) or a partial view considering services (software as service, service-based architecture, etc.).

This paper advances these topics further. It leverages service - Service Science (Spohrer et al., 2008) and Service-Dominant Logic (Vargo and Lusch, 2016) - and systems theories (Viable Systems Approach, Golinelli, 2010) to show how OSNs' communities and groups can cocreate knowledge to manage misinformation threats through endogenously generated institutions, demonstrating autopoietic and homeostatic traits. In particular, based on the literature, the following research propositions (RPs) are investigated:

RP1: OSNs affected by misinformation can be seen as viable service (eco) systems than can leverage changes in technology and institutions to survive;

RP2: OSNs facing misinformation can adapt leveraging collective knowledge systems and group decision making, selecting non-consonant experts.

Finally, linking theory to practice, the holistic service perspective on OSNs and misinformation management is translated into a conceptual model to manage this issue.

The originality of this work relies on:

- expanding service research analysis horizons to OSNs;
- providing a practical example of how Service Science, Service-Dominant Logic and Viable Systems Approach perspectives can be integrated to theorize and practically to find ways to re-shape contexts, such as OSN misinformation management; and
- presenting a multidisciplinary conceptual model for the OSN literature based on service systems and service ecosystems, linking theory to practice.

The discussion and findings could be interesting for the service research community, which could develop further studies on OSNs related, for example, to engagement mechanisms (Storbacka et al., 2016), the emergence and maintenance of communities in service ecosystems (Taillard et al., 2016), or deepening of the role of agency versus structures and technology (Giddens, 1984). Some managerial implications include the

adoption of the service perspective to build and maintain viable communication systems both within and among companies based on collective intelligence.

The remainder of the paper is structured as follows: Section 2 describes the theoretical background of the paper proposal (service systems, service-dominant logic, collective intelligence, collective knowledge systems, viable systems approach, and group decision making) and how the different theories and approaches can be adopted to answer the aforementioned research propositions; a conceptual model for misinformation management deriving from the analysis is shown in Section 3; and implications and conclusions complete the paper.

## **2. Examining OSN and Misinformation Management in Light of the Service and Systems Theories**

The paper integrates different perspectives and approaches from service and systems theories to analyse OSN and misinformation management, developing a comprehensive analysis and theorization of solutions for this specific issue. The integrated adoption of systems (and network) theories within the service paradigm was strongly encouraged by Gummesson (2017) as a valuable method to cope with complex systems (as OSNs are), in order to analyse them holistically while understanding interdependences.

This section shows how the research propositions (RPs) presented in the Introduction and connected to the different theories can be answered by analyzing different constructs (C) synthesized from reflections in the literature. Based on these constructs, a conceptual model for misinformation management is defined, suggesting phases, processes, technologies and methodologies to practically manage misinformation in OSNs.

Service science studies service systems (SSs), which are configurations of people, technologies, and other resources that interact with other to create mutual value (Maglio et al., 2009), with a specific focus on SS design, management, and engineering. This field originated during the same period as service-dominant Logic (S-D L (Vargo and Lusch, 2017) and coevolved with it over time (Vargo et al., 2010), with SS consisting of the practical implementation of the concepts developed by S-D I (Maglio and Spohrer, 2013). Indeed, S-D I focuses on the role of generic actors in integrating resources and on the capability of institutions (laws, norms, practices, symbols, beliefs, etc.) to provide guidance and, at the same time, to constrain the behavior of each actor in the context (sociological and ecological view). Since “technology is an institutional phenomenon” (Vargo and Lusch, 2016, p.11), service science plays a more normative role in analyzing value cocreation (Polese, 2018) because it leverages design and technology.

Further, the viable systems approach (VSA, Barile et al., 2012, Golinelli, 2010) has been developed to re-explore the contribution of systematic thinking to marketing and management, integrating “various ideas into a systematic whole” (Kast & Rosenzweig, 1972, p.449; Bruni et al., 2018). VSA is rooted in interweaving knowledge from various disciplines (biology, ecology, sociology, psychology, cybernetics, etc.) to offer insights into the design and management of SS (Barile & Polese, 2010, p.22).

Several studies have conceptually analyzed SSs using a VSA perspective (Barile & Polese, 2010), S-DL under a VSA lens (Polese et al., 2017b), or the three theories from an integrated perspective, as recently discussed by Barile et al. (2016). In particular, for this last contribution, a three-level approach for reorienting and reframing the thinking about systems, networks and ecosystems is proposed. SSs are addressed for their dynamic nature as viable systems according to the VSA. SSs are then observed for their networking ability to give rise to new interactions over time. Third, the service ecosystems of S-DL are considered to integrate the two others into the broad environment, also enabling by new technologies.

This section shows how the research propositions (RPs) presented in the Introduction and connected to the different theories can be answered by analyzing different constructs (C) synthesized from reflections in the literature.

Table 1. Synthesis of RP, C and the main related concepts for OSNs and misinformation management understandings

Research Propositions (RP) and Constructs (C)	Main Related Concepts
RP 1: OSNs affected by misinformation can be seen as viable service (eco)systems than can leverage changes in technology and institutions to survive.	See below
C1.1 OSNs as SSs	Service logic (every user or stakeholder is not a receiver but a cocreator) Systemic and holistic views of cocreation Focus on technology
C1.2 OSNs as a service ecosystem	Institutional arrangements Dynamic changes Focus on shared institutions
C1.3 OSNs as viable systems	System survival Supra-system Adaptation (autopoiesis and homeostasis) Consonance and resonance
RP2: OSNs facing misinformation can adapt leveraging collective knowledge systems and group decision making, selecting nonconsonant experts	See below
C2.1 OSNs can cocreate knowledge by implementing collective knowledge systems	Collective intelligence Collective knowledge systems
C2.2 OSNs can leverage collective knowledge systems to involve nonconsonant experts from the OSNs' communities to make decisions about rumors.	Group decision making

*Construct 1.1: OSNs can be seen as service systems (SSs)*

The conceptualization of OSNs as SSs can provide a theoretical framework to analyze the phenomena that occur within the OSNs with the “tools” of service and systems theories.

Indeed, according to both SS and S-DL, service is the application of competences (such as skills and knowledge) and other resources of an actor for the benefit of another (Vargo and Lusch, 2008), and it is the only reason why there are exchanges on markets. Thus, posts, images and videos are not goods exchanged on OSNs but resources that can be potentially integrated with others to exchange service. The value cocreated by means of Actor-to-Actor (A2A, Wieland et al., 2012) interactions is appreciated and perceived differently by every actor who participated in the process, depending on needs, use, and interpretation, and from the wider context in which the cocreation occurs (Lusch and Vargo, 2014).

Moreover, introducing the focus on the properties of the entire system with a system perspective (Ng et al., 2011), the properties of the components (reductionism) can be analyzed while understanding the patterns that are present at the system level (holism) (system thinking, Checkland, 1981). This approach implies adopting a multidisciplinary perspective on SSs, which can integrate, among other factors, management, soft computing, governance and operations, according to the proper nature of service science (Spohrer and Kwan, 2009).

A comparison of elements of SS and OSN is presented in Table 2.

Table 2. OSNs as SSs

Element of SS and Service Science	Element Definition	OSN as SS
Components	A service system (SS) is “a configuration of people, technologies, and other resources...” (Maglio et al., 2009, p. 395). Although IT is a fundamental component of SSs, what really differentiate SSs from pure computational systems are people (Spohrer et al., 2007).	OSNs are websites involving a network of people provided by several features, such as blogs, discussion groups, etc. (Harris, 2009)  The social net is the social capital of SSs (Batt, 2008), while the ICT net is the way in which people engage with computing to execute new processes by means of semantics that place machines and people together (Demirkan and Goul, 2006).  Resources are, for example, text messages, photos, videos, and podcasts but also knowledge about facts and events.
Interaction within and with SSs	The components of the SS configuration “interact with other service systems” (Maglio et al., 2009, p. 395).	OSN users interact with other users and with other OSNs and social platforms (of newspapers, streaming videos, wikis, etc.).
Value cocreation	Value is an “improvement in a system, as judged by the system” (Spohrer et al., 2008). In SSs, components are connected via value propositions (Maglio and Spohrer, 2008) and interact with and create mutual value by exchanging services (Maglio et al., 2009).	Value proposition in OSNs is represented by the social profile of a user and his or her preferences, networks and posts on the OSNs. OSN technology allows users to find experts, achieve awareness of a particular context or network, keep in touch with other users (Becks et al., 2004), and support the exchange of implicit knowledge through the sharing of messages, multimedia content or links and the creation of web content (Edvardsson et al., 2011b),  Thus, users of social media platforms cannot be considered merely as consumers or information “receivers”; they are instead information cocreators (Graham et al., 2009; Jahn & Kunz, 2012).

Under a service perspective, reading OSNs as SSs allows for considering that the interactions among components of the OSN are enabled and constrained by technology and are due to service-for-service exchange. In other words, actors’ disposition to engage and the action of engaging in service exchanges with others (Storbacka et al., 2016) are due to access to the resources of others provided by OSNs’ peculiar features (and the embedded norms) and the assessment - based on their knowledge and needs - of the value proposition embedded in these resources (or the value cocreation proposal, Eggert et al., 2018). Value cocreation, mainly in terms of knowledge, constitutes the outcome of the OSN.

Under a systemic and holistic perspective, the value cocreated in OSNs is not only confined to the users involved in the exchanges, which can accelerate learning and enlighten decision making (Ramaswamy, 2009). In contrast, value cocreation improves the OSN as a whole for two reasons. (i) The exchange enriches the OSN. Indeed, users’ interaction on an OSN (e.g., the sharing of a post) has a potentially amplified impact on the entire relational network as opposed, to a few beneficiaries whom a user would contact in the physical world. In this sense, there is a significant growing literature (Barrett et al., 2015) based on the assumption that digital technologies and artifacts are platforms that can liquify (i.e., decouple from their original instantiation in physical form) and mobilize resources to become readily available to actors engaged in service exchanges (i.e., increasing resource density) and result in service innovation (Lusch and Nambisan, 2015). (ii) The exchange enriches the engagement of the single individuals with the OSN more than being oriented toward single individuals (Park and Kim, 2013). This perspective has been investigated, for example, in the field of company OSNs, in which the propensity of engaged customers to participate actively in sharing messages and recommending sites to potentials has been observed (Martin and Patricio, 2013).

#### *Construct 1.2. OSNs can be seen as service ecosystems*

By enlarging the view to multiple interacting SSs and shifting the focus from adopted technology to shared institutional arrangements in general (rules, norms, interpretation schemes, symbols, practices, etc. (Kjellberg and Helgesson, 2007), the service ecosystem perspective can be introduced (Lusch and Vargo, 2014).

Service ecosystems are systems of interacting actors that cocreate value and are enabled and constrained by shared institutional logics. These shared logics, for example, enable them to better perceive the value proposals

underlying other actors' resources (Koskela-Houtari and Vargo, 2016) and easily exchange services because of common cocreation practices (Frow et al., 2016).

The interacting OSN's groups, together with other stakeholders (brands, advertisers, etc.) and other connected apps and social media, constitute a service ecosystem. In this system, among the shared institutional logics, the various users share the same environment and a common point of view of reality. When there is a little agreement on this point, as when misinformation is spread and repeated, users lose this sense of commonality and consequently lose engagement in the OSN.

Service ecosystems dynamically change over time and adapt by seeking viable conditions (Lusch and Vargo, 2014). Indeed, under a sociological perspective (Giddens, 1984), humans act within social rules, norms, collective meanings, etc. (i.e., institutions), but they can also exercise their agency or adopt new boundary objects (Sajtos et al., 2018; Gambarov et al., 2017) to recursively shape the institutions, eventually enlarging the ecosystem to improve the viability of the service ecosystems (Wieland et al., 2012).

Thus, OSNs' users can actively introduce changes into OSN practices to foster cohesiveness with the communities (also OSNs' groups) and to increase potentials for value cocreation.

### *Construct 1.3. OSNs can be seen as viable systems*

Some researchers in the field of OSNs have linked viability to commerce by considering OSN commercial viability as a measure of the desirability of commercial outcomes derivable from social network mobile applications (Phang et al., 2014). A deeper and wider conceptualization of OSN viability can be provided by adopting VSA (Barile & Polese, 2012; Golinelli, 2010). Some examples allowing for the explanation of important properties and behaviors of OSNs are shown in Table 3, in which both users and OSNs are interpreted as viable systems.

Table 3. OSNs as Viable SSs

Concept	ofVSA Definition	User as Viable System	OSN as Viable System
<b>VSA</b>			
System definition	A system is a configuration of components that interact for a purpose (Barile & Polese, 2010).	Every user of an OSN (people participating by themselves or mediating for a company, such as social media marketers) can be seen as a system with the purpose of exchanging fun, providing friends, etc.	An OSN comprehends users and other stakeholders, such as its inventors, its software technicians and developers, its sponsors and its top management, which can make decisions about the governance and operations of the OSN with many purposes.
Survival	The primary purpose of a system is to survive over time (system viability) (Barile et al., 2012)	As a general purpose, users act on the OSN to cocreate value with a wider community and to survive over time.	The main purpose of an OSN is to remain online and survive over time.
Supra-systems	The survival of systems depends, among other factors, on alignment (consonance) with other systems reputed to retain critical resources (supra-systems) (Polese et al., 2017a).	The survival of users can depend also on OSNs when they believe their participation and cocreation activities on social networks are an important component of their lives (Sigerson & Cheng, 2018). In this case, OSNs can be seen as users' supra-systems. Clearly, as OSNs lose reliability, users lose interest and engagement in OSNs, which are not reputed as supra-system anymore.	The survival of OSNs depends on users cocreating data, content, traffic, emotions, and other interactions on the OSNs. Thus, users can be considered OSNs' supra-systems. The continuous publication of fake news, news denials, and rumors negatively impacts user perceptions of the reliability of the news shared on an OSN. This impact causes the context of value cocreation to become hostile, reducing the attractiveness of the value propositions of each user and of the OSN as a whole. In this context, users can lose engagement with the OSN and their willingness to integrate resources. Conversely, the whole OSN cannot show alignment with users (supra-systems). Thus, misinformation is one of the primary threats

System adaptation	<p>Systems can align with supra-systems and struggle to survive through adaptation. They can rely on autopoiesis (self-organization) and homeostasis (external regulation compliance and internal self-regulation) (Barile &amp; Polese, 2010).</p> <p>With its origins in biology, autopoiesis (Maturana &amp; Varela, 1975) is a property of systems that reorganize themselves to generate equilibrated internal conditions with respect to both internal possibilities and external constraints.</p> <p>Homeostasis (Beer, 1975) pertains to natural science and involves the ability of systems to maintain a state of internal equilibrium by means of compliance with external normative regulation and internal self-regulation, defining, for example, a business code of behavior.</p>	<p>When users perceive that OSNs are supra-systems and are attempting to take initiative to manage misinformation, they can be available to cooperate with the OSNs (reorganizing and renorming themselves) to be aligned (consonant) with them and share the same purpose of OSN viability to re-establish the truth.</p> <p>In VSA parlance, when users and the OSN's top management collaborate through harmonic interaction, they show resonant traits.</p>	<p>to OSN viability (Editorial Board in The Washington Post, 2016)</p> <p>Many OSNs have identified the introduction of technological solutions, such as automatic data analyses and machine learning for fake news detection (see Table 3), as the reorganization strategy needed to show attention and alignment to OSN users. However, there are many cases in which no algorithm can tell the truth since even humans are not convinced about the falsehood of some statements.</p> <p>Luhmann (1995) maintained that social systems can show autopoietic traits on the basis of communication and its three components: information (what is being communicated); utterance (how and why, the reason for communication); and understanding (which depends on the listener more than the speaker).</p> <p>Given the pressure of misinformation, OSNs can involve a participatory communicational logic on decisions that can act as a guide toward a shared goal. Thus, the viability of an OSN can be fostered by normatively incorporating the social community into the decision support systems processes (Wu et al., 2018).</p> <p>Self-regulation can be put in place by means of control mechanisms (such as the adoption of abuse-gathering platforms and commissions of judges) and other rules.</p>
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As presented in Table 3, there is a positive reinforcing loop of engagement of users with the OSN when they attempt to align with each other and adapt to coevolve together.

Finally, the fascinating VSA concepts of consonance and resonance between two systems (individuals, social system, etc.) can be detailed by means of the model of information variety (derived from the requisite variety of Ashby, 1958), to derive some considerations on misinformation understanding.

In particular, the model of information variety accounts for the symmetry of information varieties among the involved systems based on the following three dimensions (Barile & Saviano, 2013):

- information units, which is the number of single units of data detained by a system (the structural knowledge of the system);
- interpretation schemes, or the cognitive schemes according to which the information units are assembled and understood (the knowledge “shape” of the system) based on the context; and
- categorical values, which are the basic values and strong beliefs of the system (the resistance to change) that influence the way in which the interpretative schemes are used.

As a result, the knowledge of an OSN is not the sum of available information units, and the interpretation of news (an information unit) depends on the information variety of the reader (observer).

Moreover, the addition of new information changes the information variety of the observer in different ways, according to the initial information variety. In fact, some people might consider the news to be another fact of no practical importance, while others can elaborate on it and change their perspectives about a certain phenomenon or even change their way of interpreting reality. Thus, artificial news “customized” by the information variety of specific readers can have very serious impacts.

As shown in the previous constructs, OSNs can be interestingly analyzed according to service and systems theories, providing different but coherent findings. For the aforementioned considerations, it derives that, to survive misinformation, which undermines the viability of OSNs by reducing the engagement of users in value cocreation processes, OSNs need control mechanisms (self-regulation) and the adoption of new technologies (machine learning or other automatic techniques), communication actions, and the decision making of users (autopoiesis). Thus, the demonstrated research proposition is the following:

RP1: OSNs affected by misinformation can be seen as viable service (eco)systems than can leverage changes in technology and institutions to survive.

*Construct 2.1. OSNs can cocreate knowledge by implementing Collective Knowledge Systems.*

An interesting phenomenon of engagement in and with OSNs is collective intelligence (CI), which can be defined as “groups of individuals doing things collectively that seem intelligent” (Malone et al. 2010, p.2). CI is a form of subjective mobilization of individuals for ethical and cooperative reasons (Lévy, 1994) according to how different microcontributions to the understanding of a phenomenon (Nielsen, 2012) can multiply, instead of summing the intelligence of individuals (Kerckhove, 1995). By this logic, intelligence is stored knowledge that can be recalled by individuals or society (LaDuke, 2008). Woolley et al. (2010) reported a psychometric methodology for quantifying CI, showing that groups are able to perform well on an enormous set of problem-solving tasks. Wise et al. (2010) empirically proved that groups that leverage CI could outperform single individuals (Wikipedia is a very popular example given that the world’s largest encyclopedia presents articles and information created by users without any central coordinating mechanism or reward).

Recently, a study by social physics researchers (Noriega-Campero et al., 2018) showed that a group within a dynamic social network (that is, a network that can change by creating new or different relationships) is able to outperform its best performing member by far, and its individual capacity to make judgments substantially benefits from engagement with the group. It was thus concluded that dynamic social networks are adaptive mechanisms for refining individual and collective judgments. Similarly, CI is based on the knowledge creation theory (Nonaka and Takeuchi, 1995), in which cognitive systems (individuals) can have an impact on the development of a social system (such as a community, like a group of individuals on an OSN), which can in turn influence their beliefs. Thus, CI encompasses and surpasses many conceptualizations, such as open innovation, crowdsourcing and the wisdom of crowds (Wise et al., 2012).

From a computational perspective, CI principles can be implemented and fostered by collective intelligent systems, which is a type of sociotechnical system, the reference architecture framework of which – enabling the implementation of collective intelligence features within existing systems – was proposed by Musil et al. (2015).

OSNs can allow for the implementation of a specific type of CI systems represented by collective knowledge systems (CKSs), in which small groups of engaged users cocreate information artifacts that can be searched by other users who need information (Gruber, 2008). There, both humans and machines actively contribute to the resulting intelligence. One of the key characteristics of CKSs is the presence of user-generated content. The system is also able to draw inferences by means of knowledge-extraction approaches, thus producing answers and results that cannot be found explicitly in this content. The emerging knowledge is extracted, enabling a shift from gathered and individual intelligence to CI.

OSNs can be CKSs, as in the case of the OSN RealTravel described by Gruber (2008). This platform processes every user contribution (photos, tags, and discussions) to classify content based on proprietary algorithms. Users in need of travel recommendations are then clustered depending on their preferences and status by means of the answers to some questions. Finally, by matching the characteristics of the users with the content (both of which were obtained by semantic analysis), the system was able to provide recommendations to users in need.

*Construct 2.2. OSNs can leverage collective knowledge systems to involve nonconsonant experts from the OSNs’ communities to make decisions about rumors.*

The introduction of the new norm of validating suspected news (homeostatic trait) by involving the community in managing misinformation might be intended as the adoption of a new institution to foster cohesion among ecosystems’ actors.

Although there is a blurred line between those who influence and those who are influenced (Allon & Shang, 2015) in an OSN, it is commonly understood that one of the primary principles of OSNs is opinion leadership (Zhang & Dong, 2008; Phang et al., 2014), according to which there is a small number of individuals who can be asked to offer advice, and these people can easily influence the behavior of others. It must be pointed out that



this approach is completely different from imposing the opinions of external experts selected and eventually paid for by the OSN, which cannot be trusted (Levin, 2017).

Thus, the practice of group decision making (GDM, Kiesler & Sproull, 1992) about the falsity of news performed by a valuable group of OSN users might represent the autopoietic communication needed for OSNs to survive.

When a decision should be made while respecting the opinion of all of the group members, a consensus method can be adopted. In this case, when the GDM must select one of several different alternatives (Cabrerizo et al., 2008), the GDM's process can be organized in two steps:

- a consensus step, in which a moderator can interact with a group of experts to reach the overall consensus (not always agreement) by asking for some revisions and discussion among the experts to overcome a certain threshold limit of general consensus (the consensus of the group is measured by comparing and aggregating the judgments of the experts); and
- a selection step, in which, because the consensus threshold level is reached, the best alternative is selected as the final decision of the group.

Recent studies have underscored that, in a GDM scenario, the consensus-reaching process is the most important step, working with different preference structures for representing judgments as, for example, fuzzy sets (Herrera-Viedma, et al., 2017; D'Aniello et al., 2016). Recently, an extension of a CKS using a GDM approach based on the fuzzy consensus model was proposed to manage food fraud news (Ciasullo et al., 2016), in which possible food fraud news was signaled by users to a group of experts in the field.

The engagement of experts and the whole community can be increased based on the following strategies:

- judging experts and people posting news belonging to the community can be rewarded with a competence score in a positive spiral of growing social identity within the community (Black & Veloutsou, 2017); and
- other users of the OSN can perceive the reliability of what they read and learn in a resonant relationship with the community (while the nonconsonant behaviors of writers of inaccurate or fake news and rumors are pushed away).

VSA concepts of consonance and resonance between two systems (individuals, social system, etc.) are adopted to further elaborate on the composition of the group to perform GDM. Indeed, these groups should be clearly composed of experts in the field of the identified rumors. However, they should also be consonant with the OSN and share the same purpose of OSN viability. In contrast, they would be practically unengaged, and they might not express reliable judgment about the news.

Moreover, because interpretation changes according to interpretation schemes and categorical values, consonant experts (among them) would likely interpret news similarly. Therefore, nonconsonant experts should be preferred in the groups to amplify the analytical possibilities and the reliability of their understanding.

Thus, to provide a reliable detection of fake news by GDM, experts in the field of the news should be consonant with the OSN, devoted to OSN viability and not consonant with one another.

The lack of consonance among the group would be overcome, for example, by a fuzzy consensus method, according to which they are pushed to converge to a threshold level of consensus about the truthfulness of the examined news.

Furthermore, the greater that the relevance attributed to the OSN by the users is, the more engaged that they would be with the OSN in terms of their degree of commitment and communication effectiveness in checking fake news, which is why OSNs should continuously show how they care for their users by being aligned with their strong beliefs, at least.

Based on constructs 2.1 and 2.2, the following research proposition is demonstrated:

RP2. OSNs facing misinformation can adapt leveraging on collective knowledge systems and consonant group decision making, selecting nonconsonant experts

### **3. Proposal of a Conceptual Model to Manage Misinformation in OSNs**

Based on the concepts and vision of service and systems theories exposed in the previous research propositions and according to the multidisciplinary view of Ss professed by service science, a conceptual model to manage misinformation can be presented (Figure 1). In particular, the conceptual model, composed of three main phases,

extends the CKS model proposed by Gruber (2008) with the aforementioned concepts and applies it to misinformation management.

The process starts with a misinformation classification step when a user signals suspect news posted on the OSN. Automatic filtering of news is applied (for example, by means of the methods for fake news detection described in the Appendix, as machine learning mechanism and network analysis approaches, Conroy et al., 2015) with the aim of excluding from a human analysis identifiable fake news. Later, other potential false news is processed to subsequently identify the group of experts capable of evaluating the news. Thus, the primary topic and the required competencies to evaluate the news are identified by means of a knowledge-extraction process (for example, Alani et al., 2003; Loia et al., 2010; Gaeta et al., 2012).

Therefore, it is possible to identify the group of experts among the users of the community for fake news evaluation. In this phase, first, a candidate set of experts can be identified according to their competencies and skills with respect to the topics of the news. A semantic matching technique can be used (Giunchiglia et al., 2007) to identify the experts who possess the needed knowledge with respect to the concepts that represent the content of the news. For example, leveraging the expert-finding techniques proposed in Gaeta et al. (2014), the candidate set of experts is selected according to their knowledge, skills and attitudes (KSA). The correspondence between the topics of the signaled news and the knowledge and expertise of the users is sought by considering a variable number of experts according to their information variety, with the aim of reaching an opportune range of skills and perspectives (Calabrese et al., 2011).

Thus, a subset of experts is extracted from the candidate set to guarantee an adequate level of consonance with the OSN and the lack of consonance among them. Furthermore, the greater the relevance attributed to the OSN by the users, the more engaged they would be with the OSN, in terms of their degree of commitment and communication effectiveness in checking news. This is the reason OSNs should continuously show how they take care of their users by being aligned with their strong beliefs, at least.

The detection is then handled as a GDM problem, in which the group of experts expresses opinions about the truthfulness of the news. At this point, the lack of consonance among the group would be overcome by the fuzzy consensus method, according to which they are pushed to converge to a threshold level of consensus about the truthfulness of the examined news. Consequently, the fuzzy consensus model (Herrera-Viedma et al., 2014) can allow its users to merge different opinions to create a shared final assessment. The final decisions of experts on posted news guarantee the veracity of information for all users of the OSN, achieving the purpose to make the community cohesive and engaged in value co-creation.

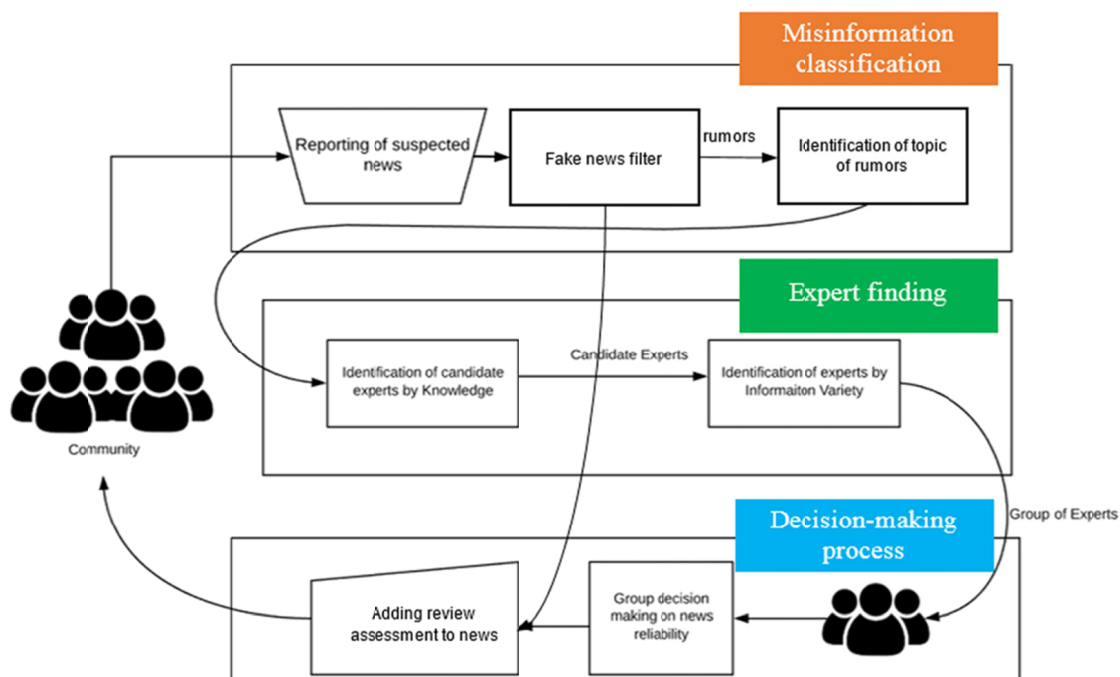


Figure 1. Model for misinformation management

#### 4. Implications and Conclusions

This paper shows a practical example of how service and systems theories can be successfully integrated to provide a comprehensive analysis and theorization of solutions for a specific issue, that is, misinformation management in OSN. In so doing, it highlights both the importance of a service and the systems view in the OSN literature, confirming what was suggested by the OECD (Koulolias et al., 2018) and the usefulness of an integration of these perspectives, as theoretically described by Barile et al. (2016). The presentation of these conceptualizations in the form of constructs (as synthesized in Table 1) simplifies the fruition and reuse of each statement. Moreover, in line with service science (Maglio et al., 2006; Maglio & Spohrer, 2008; Spohrer & Kwan, 2009), the paper closes with a conceptual model that adopts a multidisciplinary approach, based on marketing, management and computer science, to manage the enormous issue of misinformation (due to fake news, rumors, etc.) afflicting societies and OSNs' viability.

Several theoretical and practical implications can be derived from this study.

First, it is confirmed that technology and other institutional arrangements, such as norms, practices and symbols, cannot work in isolation but should consider the existing structures of the service ecosystems into which they are introduced (Barile et al., 2017). In other words, the technological focus of SSs must be complemented by the institutional focus of S-D I. Indeed, in the presented example, introducing mechanisms of collective intelligence (by means of collective knowledge systems) for rumor detection or even introducing automatic systems for fake news detection without leveraging users' engagement is a useless job because communities need to know and feel OSNs' attempts to align with their needs and take care of them to foster users' participation and to reduce misinformation.

However, researchers should examine the potentialities of CI in OSNs in depth, proposing new CKSs able to exploit user knowledge potentials and the enormous amount of time spent on OSNs.

Second, from a relational point of view, users and community engagement in OSNs should be further studied under the service lens to identify the determinants of users' loyalty and transparency on OSNs, which can cause them to avoid spreading rumors, signal suspected news, and actively participate in fact checking by providing opinions.

Indeed, starting with the transformation of virtual user interactions into collective intelligence through the internet and websites (Lévy, 1994), the CKS can respond massively to emergencies (Vivacqua & Borges, 2012) and fight misinformation propagation.

Clearly, the concepts of service-for-service exchange, the role of institutions, and the shaping of the context of exchanges of S-DL can be leveraged to develop these studies. Social physics (Pentland, 2014) can also support these studies, with its recent advancements in user behavior.

The reinforcing loop of users' engagement with the OSN and OSN viability (Table 3) confirms that members from the community can be the most engaged actors to solve the problems of the community itself in every field. In this sense, one interesting consideration is related to the engagement of users with the OSN as a whole and the need to select news judges consonant with and sharing the same purposes relating to the viability of the OSN. In contrast, judges can be inspired to engage in opportunistic behaviors and attempt to damage the image of the OSN by making fake judgments, which is clearly applicable to any decision-making problem adopting group decision making techniques.

Third, from a sociological point of view, the need has been emphasized to introduce changes in institutional arrangements to render the community cohesive and engaged in value cocreation. However, it seems clear that, due to the abundance of data on relationships and interactions, OSNs can represent a powerful testbed for studies oriented toward identifying the determinants of service ecosystems emergence (Taillard et al., 2016) and viability (Polese et al., 2017b; Carrubbo et al., 2017) and the exercise of the dark side of agency (Mele et al., 2018), not only by means of fake news spreading. This is because of interactions among different SSs possessing critical resources allow the desire to reach collective mutual satisfaction, in which the active contribution is multiple, the integration is the highest, and complementarity is fundamental (Maglio et al., 2006; Demirkan et al., 2011a; 2011b).

Fourth, from a managerial point of view, the proposed conceptual model can be a starting point to develop further misinformation management solutions for both large and small OSNs, such as those used in companies, for which CKS can find successful implementations. For example, in project management, they can be used to assess the earned value of ongoing activities, in which a first estimate (as a rumor) can be released by the activity responsible, or decisions can be made about alternative technologies, purchasing, and consultants, implying both

known and unknown risks. Indeed, the alignment of visions and actions is critical for any organization, and GDM can support the reconciliation of differences in a complex environment (Saaty & Peniwati, 2013). Therefore, innovative technologies, including many web applications (such as wikis, social networks and collaborative software) constitute a paradigm shift in the way that management makes decisions that should account for the diversity of expertise (Bonabeau, 2009). In these cases, considering the consonance of information varieties (considering both knowledge and values) can render GDM more effective.

From a practical point of view, practitioners in the field of OSNs should be aware of service and systems theories, not only to cope with misinformation but also to design and develop a context for value cocreation. For example, making algorithms transparent according to the posts that are ranked and proposed to users and implementing a CKS for the scope could improve the algorithms while increasing the trust and engagement of users in OSNs.

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#### **Appendix: Short literature review of fake news detection methods**

The need to stop the increasing proliferation of fake news on social media that are disseminating disinformation by influencing and conditioning people's opinions has been widely recognized (Gahirwal et al., 2018).

Lazer et al. (2018) identified two categories of interventions: those aimed at empowering individuals to evaluate fake news that they encounter; and structural changes aimed at preventing the exposure of individuals to fake news. In accordance with the first approach, some researchers have advocated increasing awareness of potential misinformation in digital online environments and public engagement by educators, librarians, and information specialists by promoting good digital literacy practices (Chen et al., 2015). Moreover, there has been a proliferation of efforts to provide critical information skill training through primary and secondary schools (Jones, 2017).

With regard to structural changes, other researchers have proposed using automated assistance tools to aid both content creators and consumers in evaluating the credibility of online news. In particular, the general process for automated fact checking has been described as involving the following four steps (Babakar, 2016): (i) monitoring of data sources; (ii) fact identification; (iii) fact extraction; and (iv) fact checking. This classification is adopted in the following to report some of the recent approaches proposed in the literature.

Recent approach for fake news detection	Details of the approach	(i) sources monitoring	data(ii) identification	fact(iii) extraction	fact(iv) checking	fact
Linguistic approaches	detection of predictive deception cues in text (Feng & Hirst, 2013)					X
Network analysis approaches with linguistic and deep learning approaches	hybrid neural networks to integrate metadata with text to improve a text deep learning model (Wang, 2017); deep neural network-based models to manage stance detection (Chaudhry et al., 2018), which is the task of classifying the attitude expressed in a text (Augenstein et al., 2016); exploitation of "network effect" variables (Chu et al., 2010; Ciampaglia, et al., 2015)	X	X	X		
	identification based on propagation analysis, which is different from real news even at early stages of its spread (Zhao et al., 2018; Wu & Liu 2018; Cui et al., 2017)					X
Domain-specific heuristics and semantic grammar	(Middleton et al., 2018; Walenz et al., 2014); sentence classification (Hassan et al., 2015); evidence extraction from social media content (Middleton & Krivcos, 2016)				X	
Digital image analysis	(Middleton et al., 2018; Zampoglou et al., 2017; Huh et al., 2018) because fake images are often realized through photoediting and manipulation tools					X

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