Social Informatics Research: Schools of Thought, Methodological Basis, and Thematic Conceptualization

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Research activities related to social informatics (SI) are expanding, even as community fragmentation, topical dispersion, and methodological diversity continue to increase. Specifically, the different understandings of SI in regional communities have strong impacts, and each has a different history, methodological grounding, and often a different thematic focus. The aim of this article is to connect three selected perspectives on SI—intellectual (regional schools of thought), methodological, and thematic—and introduce a comparative framework for understanding SI that includes all known approaches. Thus, the article draws from a thematic and methodological grounding of research across schools of thought, along with definitions that rely on the extension and intension of the notion of SI. The article is built on a paralogy of views and pluralism typical of postmodern science. Because SI is forced to continually reform its research focus, due to the rapid development of information and communication technology, social changes and ideologies that surround computerization and informatization, the presented perspective maintains a high degree of flexibility, without the need to constantly redefine the boundaries, as is typical in modern science. This approach may support further developments in promoting and understanding SI worldwide.

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Received July 7, 2018; revised April 18, 2019; accepted June 5, 2019

Introduction

Social informatics (SI) research has developed in environments with different intellectual traditions, and hence, is strongly associated with corresponding (regional) scientific communities, labeled here as *schools of SI*. The substantive differences among the schools make a mutual awareness difficult; this has been increased by language barriers, as well as with specifics in scientific positioning, evaluation approaches, publication strategies, academic promotion systems, and communication patterns. Relatively independently, various studies (Petric & Atanasova, 2013; Rosenbaum, 2014; Smutny, 2016; Vehovar, 2006) have identified similar sets of five to seven schools (see Schools of SI, below).

The problems with a common SI research denominator are all the more troublesome because SI addresses a broad area related to the interaction between society and information and communication technology (ICT), where many established disciplines already exist. On the other hand, there also appears to be a certain lack of conceptual grounding in some SI research, meaning it does not belong to any school of SI.

This all contributes to the fragmentation of SI among schools, but also to diversification within the schools. When discussing the developments in SI research in the United States (US) and United Kingdom (UK), Sanfilippo and Fichman (2014, pp. 42–47) understand this fragmentation as a specific SI developmental stage that began in 2006, and call it a "period of diversification."

However, this fragmentation could also have arisen because, from the very beginning, SI is not a well-defined field (Nakata, 2008), even in the foundational work of Kling, Crawford, Rosenbaum, Sawyer, and Weisband (2000). Consequently, the term *SI* can be understood in different ways (Kling, 2007). This is partially rooted in the meaning of the words *social* and *informatics*. Namely, not only in US

English, but also in general, the term *SI* is a neologism (Kling, 2007), whose meaning can be interpreted in different ways. The word *social* alone can refer to (a) society in general (that is, people, public, and humanity). However, it can also refer to (b) a specific meaning (that is, association), (c) the notion of socializing (that is, partying), and (d) social work. When translated into other languages, this Latin origin term gains further nuances. In numerous languages, the term *social* remains unchanged when translated (for example, French), or is translated more or less directly (for example, Czech *sociální*), but sometimes the root changes (for example, Slovenian *družboslovna*). The greatest linguistic difficulties arise when a direct translation does exist (for example, German *sozial*) but has a specific meaning, such as being related to social work. Increasing linguistic difficulties, the term *social* can be replaced with *socio-*, which can have various meanings, including social, sociological, and societal. Consequently, the translation to *socioinformatics* (or *socio-informatics*) can be very close to SI in some languages.

Problems can also arise from the term *informatics*. When implementing computers in the US during the 1960s, three subareas emerged (Gupta, 2007; Hjørland, 2014; Jesiek, 2013; Smutny & Dolezel, 2017): (a) the design of computers and computer systems (computer and electrical engineering), (b) computational processes (computer science), and (c) information processes (library and information science and information systems). Europe, which was divided for almost 50 years into the Western and Eastern Blocs, saw efforts to incorporate these subareas into a single umbrella term. In the Western Bloc, the French conception of informatics (Mounier-Kuhn & Pégny, 2016) emerged, with the corresponding subareas being (a) engineering informatics, (b) theoretical informatics, and (c) applied informatics. This terminology successfully spread across Western Europe as well as to other countries (Coy, 1997).

In the Soviet Union, the first unifying term for computing disciplines was *cybernetics*; the term *informatics* later emerged independently from the developments in France and had a specific ideological reason behind it: to disentangle the area of scientific and technical information from library science, which was in the firm grip of censorship (Cejpek, 2008, pp. 165–167). Mikhailov's conception of informatics (also known as the theory of scientific information) later became part of general informatics. In the 1960s, the three corresponding subareas were (a) technical cybernetics; (b) theoretical cybernetics; and (c) automated management/control systems, the theory of scientific information, economic cybernetics, and other competitive views. In the late 1970s, the word *cybernetics* was partially replaced by *informatics* (Kolin, 2006; Shkurba, 1995). In the 1990s, the notion of informatics also appeared in the US but referred to a strong application-oriented domain with roots in library and information science. Formally, in the US, the term *informatics* first appeared in the Classification of Instructional Programs in 2010 and focused on computer systems from a user-centered perspective (NCES, 2017).

Within the context of relatively independent historical developments of SI across different regions and languages, the aim of this article is to provide an overview of the schools of SI and relate them to methodological approaches and thematic areas. This forms a basis for a comparative framework that can help understand the differences in SI research developments. A related aim is also to stimulate the connections between the SI schools and to place further developments onto more solid foundations.

Schools of SI

The literature has already identified various SI research streams, which appear under different names: SI approaches, SI paradigms, or SI concepts (Smutny, 2016); SI versions (Rosenbaum, 2014); SI traditions (Petric & Atanasova, 2013); and SI developments (Vehovar, 2006). As mentioned, in the current article these research streams are called the schools of SI. Here, the notion of *school* serves only as a pragmatic working label, while precise terminological discussions are beyond the scope of this article, particularly because even SI itself is labeled inconsistently. Namely, SI can be considered a scientific and intellectual movement (Rosenbaum, 2014), epistemic community (Sawyer & Hartswood, 2014), discipline (Vehovar, 2006), subdiscipline (Greyson, 2019), approach (Marcinkowski, 2016), or field of study (Kling, 2007). The criteria for a school of SI, as understood here, are very pragmatic:

- It has elements of a scientific and intellectual movement (Frickel & Gross, 2005).
- It addresses a combination (bidirectional relationship) of society and ICT.
- It explicitly labels its research as SI in the original language or translated into English (only in very specific linguistic circumstances is the English translation socioinformatics also considered).

Some schools define SI explicitly, others implicitly, with more or less precise borders. Some schools influence others, while some remain isolated within their groundings. Each school has its own history related to some existing academic disciplines, particularly informatics, information science, library science, sociology, psychology, media and communication studies, social work, education, sociotechnical systems research, sustainable development, and social sciences research methodology.

The domain of SI research considered in this article is based on five established bibliographic databases: Google Scholar, Scopus, Web of Science (WoS), eLibrary.ru, and J-Stage. The first three databases are global, approaching or surpassing one hundred million documents, while the latter two are region-specific (that is, Russia and Japan) with a few million documents. Among others, all available documents with the term *SI* in the titles (around 400 entries) were reviewed for the purpose of this article.

The overview below is based on SI schools identified in previous research (Petric & Atanasova, 2013; Rosenbaum,

DOI: 10.1002/asi

2014; Vehovar, 2006) and particularly by Smutny (2016), who summarized the comprehensive SI developments from over almost 50 years, citing more than 200 sources. In this article, however, Smutny's (2016) entire reference list is not replicated, but only the essential sources. New references are added and the structure is slightly refined, along with the labeling of schools. Potentially, other SI schools might exist, but could not be identified, at least using the above criteria and domain. The SI schools are named after their initial countries of origin, but researchers from other countries might have joined later. Nevertheless, these country labels are a working terminological compromise and are not the best solution for all the cases. The schools are presented in alphabetical order.

The German school, labeling its research as *sozioinformatik*, is part of the informatics field and emerged in around the year 2000. Although based on the German research tradition related to the use of ICT, it also refers to the US school of SI. However, the scope of the German school seems to be narrower, focusing on the interactions of software with individuals, organizations, and society. Thus, German researchers primarily address the social context of the acceptance of software applications and the ways in which technical and social components shape one another (Zweig, Neuser, Pipek, Rohde, & Scholtes, 2014). These are important complements in the artifact (that is, method and model) design, particularly when defining problem contexts and evaluating artifacts (Rohde & Wulf, 2011). Despite considerable overlap with the US school, German researchers commonly define their school as separate, even in international discourses. Because of language specifics, however, they translate *sozioinformatik* into English as *socio-informatics* (Wulf, Pipek, Randall, et al., 2018), not as SI. This relates to the specifics of the German language, where the direct translation of SI as *sozialinformatik* means a specific implementation of ICT in social service organizations (Janatzek, 2017, p. 115; Jurgovsky, 2002; Kreidenweis, 2012, p. 26); on an interdisciplinary level, this includes the social, educational and health sectors (Janatzek, 2017, p. 115). Official beginnings date to the 1990s, but the roots reach as far back as the 1980s (Kreidenweis, 2012, p. 19).

The Japanese school refers to its research either as socioinformatics or as SI, which, in Japanese literature, are equivalent and interchangeable English notions for the Japanese term "社会情報学" (Kurosu, 2010; Masamura et al., 2013). In Japan, the notion of *informatics* is understood as a discipline that studies information and is already strongly connected to the humanities, social sciences, and natural sciences. In Japanese, the term *information* has a double meaning within the SI context: it plays a role in defining the range of objects to analyze, but it is also the object of analysis (Kurosu, 2010). SI covers a broad scope, including various aspects of how information influences humans and society from the micro to the macro level. Its methodology has a teleological and strong interdisciplinary character because of its focus on the central concept of information (Endo, 2012). By definition, SI connects the cultural sciences, social sciences, engineering, and medicine fields and is thus positioned more as a broad, open area rather than a closed field of study. Consequently, each university with an SI study program has its own specialization (Smutny, 2016). The beginning of SI research in Japan dates back to the 1990s and is also connected to the early developments of information society research (late 1960s) and corresponding information exchange (Yoshida, 2008).

The Norwegian school has its roots in sociology and psychology (Maliţa, 2006). It was perhaps the earliest school, as it was already addressing the communication and social aspects of computer technology in the 1980s. The original label, translated into English as *SI*, was the Norwegian word *sosioinformatikk*, coined by Bråten and Roggen (Rosenbaum, 2014; Vehovar, 2006). This original SI research, constituting the core of the Norwegian school, was not defined very formally, and it gradually declined. Later, SI research in Norway was characterized by long-term cooperation in the area of sociotechnical approaches among researchers from Scandinavia, the UK, and the US (Sawyer & Tapia, 2007). Within this context, after the year 2000, Norwegian researchers also used the term *samfunnsinformatikk* (Godejord, 2018), resembling community informatics. Later, individual university courses further narrowed their focus to specific areas in which human–computer interactions and information processes played important roles, particularly in relation to law, business, and politics. The term *sosialinformatikk* also appeared, referring to the use of ICT in social services and healthcare (UIA, 2018).

The Russian school relates to the direct meaning of SI (социальная информатика, transliterated as *socialnaja informatika*). Its focus has significantly evolved over time because of changes in the understanding of the term *informatics*. The beginnings of SI research lie in the critical reaction in the 1970s (Sokolov, 1989; Sokolov & Mankevich, 1971) to Mikhailov's conception of informatics (Mikhailov, Chernyj, & Giljarevskij, 1968), which differed from the Western European understanding (see Smutny, 2016). SI initially focused on the social aspects of communication and information processes in society (Straka, 1990). This specific SI research merged and disappeared into communication and media studies with the dissolution of the Eastern Bloc. It also came under criticism from Ursul in the late 1980s when the current Russian school of SI took shape (Smutny, 2016), focusing on the informatization and computerization of society, along with related sustainable development (Ursul, 1990, 1993), which continues to be actively developed by Russian-speaking academics. Its target is connected to ICT implementation in all spheres of human activity (Kolin, 2003; Shitikov, 2017; Starikov, 2016), including the study of the use of information in socioeconomic areas and the related process of transforming social institutions and relations (Chugunov, 2012). Applied activities aim at developing the ICT competence of students, particularly in the field of education (Kolin, 2011).

The Slovenian school relates to the notion of *družboslovna informatika*, which translates to SI, whereas the direct translation of *socialna informatika* sounds like *social work informatics* (similar to the situation in Germany).

DOI: 10.1002/asi

The Slovenian school has developed in close interaction with the SI study program (Vehovar, 2006). Launched in 1984, it was one of the very first SI-related institutionalized activities. The program integrated social sciences, informatics, and, in particular, the social sciences methodologies, a defining characteristic of the Slovenian school. Sometimes, SI was even defined as being at the cross-section of ICT as a research tool and ICT as an object of social research (Petric & Atanasova, 2013). Consequently, the related research was closely linked to the ICT tools and methodologies developed to study the information society phenomena, particularly social network analyses, web surveys, and social computing data analytics. Later, more substantive research emerged, such as research on online communities (Petric & Petrovcic, 2010), smart technologies for active aging (Dolnicar, Groselj, Hrast, Vehovar, & Petrovcic, 2018), and the social aspects of online communication (Vehovar, Motl, Mihelič, Berčič, & Petrovčič, 2012).

The UK school is connected to the UK's longstanding tradition of sociotechnical research and even older research in the field of industrial sociology (Davenport, 2008). The aim of this research tradition was to optimize sociotechnical systems (Avison et al., 2006), which included the principle of the mutual constitution of humans and technologies. The UK has often been a site where ideas from continental Europe and the US meet. Because of the close cooperation of British and American researchers and their shared interest in the field of sociotechnical interaction, the idea of SI, introduced in the US, took hold in the UK in the mid-1990s. SI research in the UK was constructed at the intersection of information science and sociology and had a broader view of the subject than the original US definition. The UK school is based on the UK tradition of multidisciplinary research in science, technology, and society (Smutny, 2016) and is connected with the study of ICT deployment (Dutton, 1999). This research also built on the social theories used in the study of technology and technosocial aspects; for example, a social construction of technology and social shaping of technology (Williams & Edge, 1996). Many SI research centers have been established in the UK, and they are mostly focused on Internet research. In general, the UK and US schools of SI have strong mutual influences (Davenport, 2008).

In Commonwealth countries, particularly in Australia and New Zealand, SI is often connected with community informatics (Denison, Sarrica, & Stillman, 2014; Le Roux, 2009), which focuses on ICT applications addressing various community processes. The overlaps and differences between SI and community informatics are described by Gurstein (2007, pp. 42–44) and Denison et al. (2014, p. xi). In South Africa, the specific activities labeled as socio-informatics appeared as a part of information science, focusing on the relationships between human beings, organizations and their management, and informatics (Ocholla & Bothma, 2007).

The US school (or North American school) is among the youngest but is highly important because it has a certain influence on all other Western SI schools. This school also has the highest number of publications and citations in global bibliographic databases. In addition, Kling's charismatic role and impact have contributed to this school's importance, and he is often understood as the founding father of SI. Although formally emerging only in the mid-1990s, the school's roots stretch back to US sociotechnical research conducted between the 1970s and the 1990s (Kling, 2007; Robbin, 2007), and it has also drawn inspiration from research in the UK and Norway (Davenport, 2008; Sawyer & Tapia, 2007). SI was initially defined by its topic rather than by methods (Kling, 2007). SI was understood as the interdisciplinary study of the design, uses, and consequences of ICT, taking account of their interaction with the broader social environment (King, Iacono, & Grudin, 2007). SI research has three main orientations: normative, analytical, and critical (Kling et al., 2000, pp. 16–18). To complement quantitative and qualitative research related to SI, other specific approaches (for example, sociotechnical interaction networks, STIN; Kling, McKim, & King, 2003) were created to help reveal the conceptual frameworks (Fichman, Sanfilippo, & Rosenbaum, 2015, p. 37). The current SI period in this school, ongoing since 2006, is characterized by expansion of the "boundaries into new domains and with new theoretical and conceptual lenses" of SI (Fichman et al., 2015, p. 75). One of these boundary expansions can be observed in the activities of the Consortium for the Science of Sociotechnical Systems, supported by the National Science Foundation (Goggins, Floyd, Grudin, et al., 2009). The school continuously provides new updates, from literature reviews (McCoy, 2017) to a refinement of the research object (Jarrahi & Nelson, 2018), scope (Greyson, 2019), and fundamentals (Marcinkowski, 2016).

For a quick summary overview of the SI schools, Table 1 exposes the most essential sources, which contain the key ideas.

TABLE 1. Selected basic literature for each school of SI.

School of thought	Basic sources
German	*Sozioinformatik*: Wulf et al., 2018; *Sozialinformatik*: Kreidenweis, 2012
Japanese	Kurosu, 2010
Norwegian	Maliţa, 2006; Bråten, 1983
Russian	Kolin, 2011; Chugunov, 2012; Kolin, 2015
Slovenian	Petric & Atanasova, 2013; Vehovar, 2006
UK	Davenport, 2008
US	Kling, 2007; Fichman et al., 2015

Methodological Basis of SI Research

The Western (German, Norwegian, Slovenian, UK, and US) schools of SI build their knowledge mainly on behavioral and social research, using qualitative and quantitative research methods or their own analytical strategies, such as STIN (Kling et al., 2003). From this perspective, SI research is built inductively to formulate the concepts and theories

DOI: 10.1002/asi

about observed phenomena. Nevertheless, it should be added that the UK and US schools also provide ontological and epistemological grounds (for example, core principles of SI), while other Western schools are rather problem-driven, taking conceptual backgrounds and methods from other disciplines. This may also involve design research related to general artifacts (that is, methods and models) or situated artifacts (that is, software implementation). Design research extends the knowledge base of artifact design in a particular area, along with its implementation and applicability, and can involve quantitative and qualitative research (Hevner & Chatterjee, 2010) as part of the design-oriented approaches, either before (explorative research of problem contexts) or after (evaluation of solutions) artifact design. Design research within SI is thus only the phase carried out in the before–after phases because SI is not primarily concerned with the design of artifacts.

Western schools are not connected to the use of any particular methods. The US school explicitly professes methodological pluralism (Sawyer & Eschenfelder, 2002). In contrast, the Russian school relies mainly on the systems approach (Drab, 1981), which is less known in Western Europe and the US. This approach represents another way of thinking, one that historically was related to the cybernetics view and was used by a number of fields (for example, systems analysis and systems engineering) in the Eastern Bloc. The systems approach is built on abductive thinking (Campos, 2011), which is a specific type of inductive reasoning, sometimes also referred to as *creative solutions* or *inferences to find the best explanation*. Researchers introduce different perspectives on a problem and define the elements, context, and boundaries of a system based on existing knowledge, practice, and observations, with the aim of finding the best possible explanation of a given problem or phenomenon. Assertions about the phenomena in question are made and are subsequently reduced, to select the best possible explanations or solutions.

From a methodological perspective, the domain of sociology as understood in the West did not exist in the early Russian school (that is, in the Soviet Union). Consequently, the empirical approaches of the social sciences were not developed, and historical materialism replaced sociology (Skovajsa & Balon, 2017, p. 73). Similarly, behavioral and social research were suppressed for ideological reasons, and the most important concern for the systems approach and thinking became the researchers' knowledge and experience (practice). Based on this knowledge, researchers solve specific cases by defining the studied system and offering their own solutions for or views on the identified problems, which are supported by arguments (that is, abductive thinking). The differences between the two methodological approaches are summarized in Figure 1.

The Japanese school has one central premise: information influences humans—as well as a self-organized society—through communication (Kurosu, 2010). From a methodological perspective, the Japanese school is teleological in nature (Fichman et al., 2015, p. 12) and permits the selection of any methodological approach suitable for the area of research, purpose, and defined goal. This can include the analytical methods of the natural sciences and the quantitative and qualitative methods of the social sciences, as well as the systems approach. Thus, the Japanese school uses both of the approaches shown in Figure 1.

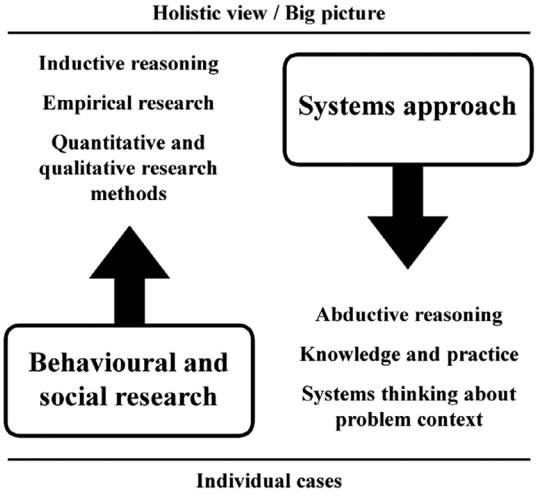

FIG. 1. Two methodological approaches to SI research.

Thematic Classification of SI Research

SI can appear in a broad array of research areas because it addresses combinations of ICT and society. Alternatively, it can be said that SI research relates to computerization of human activities, covering both the social aspects of ICT and ICT aspects of social issues. These, of course, are broad and vague definitions, supporting the general observation that the "combination of social and technological change has many names and no common understanding" (Sawyer & Hartswood, 2014, p. 199). Consequently, numerous competing, well-established labels denote various research streams, addressing aspects of the interaction between ICT and society: information science, information systems, information society, social computing, science and technology studies, ICT and society, Internet studies, information sociology, computer-mediated communication, human–computer interaction, and many others.

In principle, SI could also be understood as an overarching notion, addressing all the different interactions of ICT and societies. However, this is not the thesis of this article, because most of this research has little awareness of SI. Instead, only research that explicitly classifies itself as SI is the focus here. Still, the self-declared SI research can appear within a very broad array of potential areas. Of course, the self-declared SI research only contributes to a very small portion of the entire research addressing interaction between ICT and society. In addition, there is perhaps no SI research that could not also be classified under the label of some alternative research stream.

DOI: 10.1002/asi

Within this context, to identify the potential thematic areas where SI research can appear, the classification (Vehovar, 2006) already discussed in the literature (for example, Smutny, 2016; Marcinkowski, 2016; Petric & Atanasova, 2013; Fuchs, 2008, pp. 1–10) is updated and refined. For the first level, the thematic areas are classified according to the research origin: (1) (substantive) social sciences, (2) informatics, and (3) (social science) methodology. For the second level, the criteria are specific to each area. For the first area, (1) is the aggregation level (a. person, b. organization, c. society), then, (2) is the object of ICT applications (a. model, b. service, c. information), and finally, (3) is the stage of the research process (a. analysis, b. data collection, c. processing). As mentioned, a variety of more or less established research streams—labeled as disciplines, fields, scientific and intellectual movements, and so on—already exist in these areas. The most typical among them are used below to illustrate the themes and borders where SI research can potentially appear.

1. **The general interactions between ICT and humans** originate in the social sciences. The focus is on the social aspects of ICT implementation, use, and design in general terms. The area can be structured into three subareas:
    a. Interactions at the personal level relate to individual experiences with ICT (for example, human–computer interactions, usability, privacy, cognitive aspects, and psychological issues).
    b. Interactions at the organizational level relate to the general socio-organizational aspects of ICT implementation, including managerial and governance issues, ICT-supported group dynamics, digital labor, organizational informatics, virtual enterprises, and community informatics, among others.
    c. Interactions at the society levels (that is, regional, national, and global) relate to ICT-driven changes in society, from social networks to the social and digital divide, from computer literacy to issues of well-being, personal networks, leisure, health, education, government, marketing, and consumer behavior.
2. **The ICT applications in substantive areas related to the social sciences** have origins in informatics (understood in its broadest sense). Three subareas can be identified:
    a. Computer modeling of social sciences data, including policy simulation, decision-making models, and knowledge discovery applications.
    b. ICT services related to the areas of social sciences, particularly public services (for example, education, government, health, social care, culture, and art), as well as ICT applications in business and leisure, among others.
    c. The structuring, conceptualization, and processing of information, which is related to certain aspects of established fields (for example, information and library science) or to specific subfields, such as information architecture, information visualization, and information design.
3. **The ICT applications serving as social sciences research tools** have origins in social sciences research methodology and can be structured into three subareas:
    a. ICT-supported (statistical) analysis of social sciences research data, particularly computer-intensive approaches (for example, large social networks, bootstrapping, Gibbs sampler, data fusion, data mining, and big data).
    b. ICT-assisted data collection in the social sciences, particularly quantitative (for example, web survey data collection) and qualitative research (for example, online focus groups).
    c. ICT infrastructure for social sciences research, from tools for processing, organizing, archiving, presenting, publishing, and disseminating data and research findings to platforms for (virtual) collaboration.

This classification is broad and general but can shape a comparative framework for studying the structure and trends where (self-declared) SI research appears. More specifically, it can stand as a starting point for corresponding empirical research on SI publications.

Ideally, the areas and subareas of this classification would not overlap. However, in such a fluid matter as SI (Marcinkowski, 2016), the subareas may overlap. In addition, some SI research may combine two areas. Typically, the research on the general interactions of humans (individuals, organizations, and societies) and ICT (area 1) may have additional specifics, so the ICT involved would not be general (for example, a generic mobile device or online chat) but rather a concrete ICT application related to either substantive areas of the social sciences (area 2) or social sciences research methodologies (area 3). Most frequently, this combined SI research relates to case studies that address the general social implications (for example, privacy, ethics, and social relations) of specific ICT applications, particularly computer-mediated communication, such as Facebook, Twitter, Second Life, and Snapchat (area 2). Alternatively, the combined SI research addresses specific ICT-supported research applications (area 3), particularly the computational approaches (for example, sentiment analysis) used to analyze some general social aspects, including human behavior in computer-mediated communication.

This combined stream of SI research often lacks conceptual grounding because it is typically conducted as case studies combining specific ICT issues and selected general social aspects. Consequently, this type of SI research is difficult to assign to any school of SI. Alternatively, it can be said that it may potentially or implicitly fit into many SI schools. Intriguingly, this combined stream seems to be becoming the prevalent type of contemporary SI research, as can be observed in the International Conference on Social Informatics (SOCINFO) and its proceedings (for example, Staab, Koltsova, & Ignatov, 2018), which has been organized annually since 2009 and has focused on a broad range of matters where social research meets technical (ICT-related) research. This combined stream also appears in many other SI research efforts conducted independently throughout the world, such as the *Bulletin of Social Informatics Theory and Application* (Indonesia), the Springer series of the Institute for Computer

DOI: 10.1002/asi

TABLE 2. The 5-year trends in the number of entries related to SI in global bibliographic databases (January 2019).

	1999–2003	2004–2008	2009–2013	2014–2018
Google Scholar	1,280	4,150	12,300	17,400
Scopus	266	717	8,796	16,326
WoS	18	35	521	2,407

Sciences, *Social Informatics and Telecommunications Engineering* (Belgium), and the former *Revista de Informatica Sociala* (Romania).

An additional illustration can shed further light on this trend: the sharp increase in the number of new entries related to SI with the exact search term *SI* appearing anywhere in the publication (that is, title, text, affiliation, references, and so on). The 5-year trends of the number of such entries are shown in Table 2.

It is worth noting, however, that among the 26,519 documents with the term *SI* in Scopus, only 170 have SI in the title, with a peak of 34 documents in 2012 and a steady decline towards six in 2017 and three in 2018. Similarly, out of these 26,519 documents, only 854 refer to Kling (who is by far the most cited author in relation to SI), with a peak of 85 documents in 2006 and with a decline to 39 documents in 2018. Google Scholar and WoS also show very similar patterns. This may indicate that most of the documents with the term *SI* have little focus on reflecting SI itself and also have limited links to any school of SI. Instead, it seems that the term *SI* serves as a floating label for research addressing combinations of ICT and social research. Of course, these preliminary figures provide only an illustrative hint that deserves a serious bibliographical study.

Integration and Discussion

Table 3 summarizes and integrates the characteristics of the schools discussed in the section Schools of SI (first three columns), the methodological basis from the section Methodological Basis of SI Research (fourth column), and the thematic classification from the section Thematic Classification of SI Research (fifth column). The latter assigns thematic categories from the section Thematic Classification of SI Research to schools according to their general presentation in the section Schools of SI. The table provides a comprehensive conceptual overview and presents a comparative framework of the SI research, which can help in understanding the differences among the SI schools. It also provides insight on overlaps and distinctions.

There are some blurred overlaps among the schools, particularly among the US, UK, and Norwegian schools (Sawyer & Tapia, 2007). It should be added that due to the leading global role of the US university education system, which attracts students and researchers from all over the world, the US school has great potential for mixing ideas from other schools. On the other hand, some schools are rather isolated and defined predominantly by their thematic focus (German, Slovenian, Russian) or methods (Russian), while others, like the Japanese school, are more open to new concepts, diversification, and interdisciplinary transitions. It is also worth noting that only the "interaction between ICT and humans at organizational level" (1b) is common to all schools, and that "ICT services in areas related to social sciences" (2b) are common to all but one. Further elaboration on details related to similarities and differences from Table 3 are not discussed here, as this would go beyond the scope of this conceptual article.

Among the various schools of SI, some may overshadow others (Rosenbaum, 2014, p. 22), which could lead to a preference for a single perspective in the scientific paradigm. For instance, in modern science the evolutionary approach (Fichman et al., 2015, p. 5) typically leads to the point where the most successful community wins. However, SI requires greater flexibility. Its very nature results in constant reformulation and development, which is in contrast to a single paradigm. Consequently, by its very definition, SI research is strongly related to the continuous development of ICT and the resulting changes in society (Kling, 2000; Kolin, 2015; Sawyer & Eschenfelder, 2002). However, these changes do not always occur in the same way and at the same time; instead, they can be regionally (and society) specific (Marcinkowski, 2016). Thus, maintaining multiple schools enables using a variety of approaches and flexible possibilities to develop a general framework for comparing SI schools. Such a broad approach can also encourage researchers to extend the boundaries of their perspectives, which may stimulate their creativity and lead to the natural convergence of schools or the emergence of new ones.

Because of the numerous differences, it is very difficult to compare—or even rank—SI schools on a single dimension. In addition to all the aforementioned characteristics (Table 3), schools may be linked to specific scientific communities, also with various formal and informal rules. Consequently, views based on common scientometric indicators are not quite indicative because they are not equally relevant to all the different schools.

This can be illustrated with an example involving three citation databases: WoS and Scopus, well-known to Western scholars, and the Russian citation database, eLibrary.ru, which is known primarily in Eastern Europe and provides the so-called Russian Science Citation Index. A search for the keyword *SI* in the title of the publications (January 2019) returns the following results:

- *WoS*: TITLE ("social informatics") found 61 documents. The results refined for peer-reviewed documents (document types: proceedings papers, articles, and reviews) found 39 documents.
- *Scopus*: TITLE ("social informatics") found 170 documents. The results refined for peer-reviewed documents (document type: conference papers, articles, reviews, book chapters, and books) found 86 documents.
- *eLibrary.ru*: TITLE ("социальная информатика") found 87 documents. The results refined for peer-reviewed documents (publication type: conference papers, articles, and books) found 85 documents.

DOI: 10.1002/asi

TABLE 3. Comparative framework with current SI schools.

	Origin in existing disciplines	Typical research focus	Methodological basis	Thematic classification
German school	Interdisciplinary informatics with sociology, economics, psychology and social services	Interactions of software with individuals, organizations and society	Behavioral and social research, design research	- General interaction of ICT and humans (1a,b,c) - ICT applications (2a,b,c) - ICT infrastructure (3c)
Japanese school	Informatics (meaning a technically oriented area in Japanese), media and communication studies	Study of social information, communication and information processes in an information society	Teleological approach based on the research area	- General interaction of ICT and humans (1a,b,c) - ICT applications (2a,b,c) Fuzzy research areas
Norwegian school	Sociology, psychology, sociotechnical research	Study of the design, deployment and evaluation of information and knowledge systems	Behavioral and social research, design research	- General interaction of ICT and humans (1a,b,c) - ICT services in areas of social sciences (2b)
Russian school	Initially, library science and communication studies; currently, informatics, sustainable development, philosophy of information, education and knowledge management	Interaction between society and ICT, sustainable development, strong educational and philosophical overlaps	Systems approach	- General interaction of ICT and humans (1a,b,c) - ICT applications (2a,b,c)
Slovenian school	Sociology, statistics, informatics	Use of ICT to study the interactions of ICT and society	Social sciences methodologies, behavioral and social research, data analytics	- General interaction at organizational and societal level (1b,c) - ICT-supported analysis (3a) and data collection (3b)
UK school	Sociology, information science	Transdisciplinary study of sociotechnical interactions	Behavioral and social research, data analytics	- General interaction at organizational and societal level (1b,c) - Computer modeling (2a) - ICT services (2b) - ICT applications as research tools (3a,b,c)
US school	Information science, information systems, sociology, computer science	Study of the design, uses and consequences of information technologies in institutional and cultural contexts	Behavioral and social research, design research	- General interaction of ICT and humans (1a,b,c) - ICT services (2b)

Thus, it seems that the research from the Russian school has the same or even higher (depending on the criteria) number of peer-reviewed publications as the research in the other two overlapping citation databases. This finding is especially intriguing because the trends in the Russian database indicate steady annual production of such entries (that is, SI in the title), while Scopus, WoS, and Google Scholar show a downward trend in the past 5 years (see Table 2 in the section Thematic Classification of SI Research). The perceived dominance in the number of publications thus might not be quite so unambiguous (Rosenbaum, 2014, p. 6; Fichman et al., 2015). In addition, the amount of such publications in other languages is unknown, so the simplified assumption that they are nonexistent, negligible, or irrelevant could also be problematic. However, given that the Russian literature includes few references to English-language publications, it would also be hard to agree with the claims (for example, Kolin, 2006) that Russia is the world leader in formulating theoretical bases of SI.

The problem of mutual "invisibility" seems to exist, putting researchers who read and publish in non-English languages at a clear disadvantage (Rosenbaum, 2014, p. 22). Western researchers might view the Russian school as essentially utopian and built on philosophical and educational views (Rosenbaum, 2014, p. 11; Smutny, 2016). At the same time, the Russian school has perhaps the most viable research community whose members actively publish on SI; of course, mostly in Russian. In addition, they have different standards for understanding science, and their articles are indexed in specific citation databases, which is also perhaps why they ignore journals indexed, for instance, in WoS. It would be fruitful to overcome these limitations and establish a perspective that takes into account all the known approaches to SI (Smutny, 2016; Takazawa, 2017). In part, this is already undertaken in bibliographic databases, such as WoS, which increasingly include publications from eLibrary.ru, J-Stage, and other regional databases.

Conclusion

The current article reviewed SI research and provided a comparative framework based on the three perspectives

DOI: 10.1002/asi

(school characteristics, methodology approaches, and thematic areas) of SI research as identified within the seven schools of SI. The framework presented offers an orientation for SI researchers and can be further updated. The advantage of this approach is that it can preserve multiple approaches (that is, schools), creating the grounds needed for the constant reformulation of SI according to the developments in ICT and contemporary societies.

Despite certain tendencies towards convergence, the current article argues that SI should be understood as a postmodern science. Whereas modern science is built on a homology of experts and universalism, postmodern science builds on a paralogy of researchers and pluralism (for example, Han, Lee, & England, 2010; Kuntz, 2012). In essence, then, SI is not a single path; instead, each school brings its own specific perspective, which is developed under specific circumstances. Despite these differences, the schools share some common concepts, as well as the apparently unifying label of SI. Thus, SI is not a firm, theoretically defined stream of research; rather, it consists of research related to the self-perceived label of SI, which can appear in various contexts, areas, and forms.

In other words, instead of preferring a single viewpoint, as in modern science, where certain fields can be further constituted as formal disciplines, in SI it is more suitable to follow the approach of postmodern science and observe only a broad common discourse that includes a number of viewpoints. Doing so eliminates the modern science challenge of constantly (re)defining some fixed thematic and methodological boundaries to separate different areas. Indeed, the postmodern perspective concurs that, by its nature, SI is forced into constant reformation of its practices and aims (Marcinkowski, 2016).

Given the postmodern understanding of SI, challenges appear with respect to consolidation of SI across the schools and also with respect to strengthening the position of SI against alternative labels and competitive streams of research. Building on Sawyer and Hartswood (2014) and Fichman et al. (2015), directions to address these challenges can be as follows:

a. To balance rapid developments in empirical SI research, the Western SI schools should further strengthen the theoretical bases, which is also in accord with the normative and analytical orientation of SI (Kling et al., 2000, pp. 16–18). On the other hand, the Russian school should strengthen its empirically based research.
b. Explicit referencing to some SI conceptual basis should become more important in the combined stream of (self-declared) SI research, which often lacks any conceptual grounding. This will help SI to not be just an empty container where scholars talk about SI-related studies without any direct references to SI.
c. Because of the rapid developments in ICT and in society, it is necessary to continuously (i) validate existing theoretical basis, (ii) develop new theoretical bases, and (iii) develop new artifacts (for example, strategy, methodology, models) to support empirical research, particularly in studies on the design, understanding, acceptance, and use of ICT.
d. SI should not only learn from the past (reactive approach) but also prepare for the future (progressive approach) and provide a more visionary perspective—a characteristic of the Russian school—which can be relatively easily adopted by other schools.
e. A systematic bibliographic analysis should monitor and reflect trends in the SI research bibliography—as well as in other formal activities (for example, study programs)—with respect to the SI schools, thematic areas, and methodological approaches.

The related activities can potentially contribute to a move toward the ideal (and idealistic) situation, which is ambitiously described with the statement: "We believe, *if ICT are everywhere, so should Social Informatics be everywhere"* (Nurminen, Berleur, & Impagliazzo, 2006, p. 2). The most suitable and convenient approach to address these activities is perhaps to launch a regular conceptual track at annual SOCINFO conferences.

Increasing awareness of the different approaches to SI is highly beneficial, and the current article has attempted to contribute to this aim. However, there still remains a challenge in formulating a common definition of SI that can offer a global discourse which is simultaneously acceptable to different schools and well-grounded in a broader thematic and methodological framework. These boundaries should not be as sharp as in the modern science but looser and more overlapping. Hence, the SI framework can be further supplemented with two general views emphasizing what these schools have in common: the intension and extension of the term *SI* (Legg, 1999).

Intension refers to formulating a definition that expresses general characteristics: What is the main topic? What does it deal with or study on a general level? Which perspectives are included in this kind of research? Within this context, *SI can be broadly defined as a research field that focuses on the research of sociotechnical interactions at different levels in connection with the development of the information society, including the social aspects of computerization and informatization, which can be structured into three main areas: interactions between ICT and humans, ICT applications in the social sciences, and ICT applications as a social sciences research tool*.

Extension refers to a definition that lists the subfields or subordinate terms within a particular area of knowledge. In the broadest sense, *SI connects, at an interdisciplinary level, informatics (especially computer and information science and information systems) and the social sciences (especially sociology, communication studies, education, psychology, economics, and social sciences methodologies) and other relevant areas that deal with information processes and exchanges, social changes, communication, and mutual sociotechnical relationships within the defined system, including the philosophy of information, ethics, and sustainable development*.

DOI: 10.1002/asi

Although SI is singled out (mainly thematically) as a specific research stream at both the local and global levels, a wide scope threatens to create confusion with other areas. Therefore, SI might lose its identity and individuality under the weight of related research areas, particularly ICT and society, informatics and society, sociotechnical research, science and technology studies, computational social science, information society, information science, and Internet research. As mentioned, whenever research addresses combinations of ICT and society, numerous competing labels appear. It should be clear that the SI research discussed in the current article (that is, self-labeled SI) covers only a small portion of the work on these combinations. This is obvious in global citation databases where publications referring to SI reach, at most, 100 citations, while publications referring to alternative labels (for example, *information society*) can be easily in the 1,000s. The SI research discussed in the present article thus is related only to a specific "lens through which one can investigate sociotechnical situations" (McCoy, 2017, p. 2). Of course, this all relates only to the current situation, while the potentials of SI are much broader.

However, it is worth repeating (Table 2, section Thematic Classification of SI Research) that there exists a certain expansion—although at a rather superficial level—of the usage of the term *SI* in relation to research addressing combinations of ICT and society. Contrary to this expansion, though, the conceptual discussions on SI seem to be declining, at least in Western schools, which is noticeable in the decreasing number of documents with titles including SI in global bibliographic databases, as well as in the decreasing number of documents that cite Rob Kling. This also indicates that the SI research explicitly belonging to a certain school of SI has a decreasing share of the entire research that self-labels itself as SI. Of course, these findings are only illustrative indications of recent trends, so future research on SI may conduct a rigorous bibliographic study on this matter.

Nevertheless, this apparent contradiction could present a potential push for a more formal and unified revival of SI research that could gain in popularity among (a) researchers in existing schools of SI, (b) researchers who (superficially) use the label *SI* for their work but neither belong to any SI school nor refer to the authors from these schools, and (c) researchers addressing the combination of ICT and society under other labels.

Funding

The authors received public financial support from research grant P5-0399 administered through the Slovenian Research Agency and grant F4/1/2019 of the University of Economics, Prague.

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