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The Facets of Sociomateriality: A Systematic Mapping of Emerging Concepts and Definitions

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Abstract. Sociomateriality is gaining momentum and is by now characterized as a research stream in the information system field. Although some definitions emerged, there is still uncertainty about how to conceptually and analytically address sociomateriality. The debate ranges from understanding sociomateriality as just a fancy word for technology to treating it as a de-facto theory of the human-technology relationship. To bring the field forward, a common basic understanding of what sociomateriality entails is needed. In this paper we set out to contribute to such an understanding. We do this by conducting a systematic mapping study of emerging concepts and definitions in the current empirical body of literature on sociomateriality. Our analysis finds three key resulting facets: mutuality (*what* is a sociomaterial assemblage?), performativity (*how* does it perform?), and multidimensionality (*When* and *where* does it perform?). Our findings outline how sociomaterial studies analytically and methodologically address performativity spanning across time and space.

Keywords: Sociomateriality; Systematic Mapping; Mutuality; Performativity; Multidimensionality.

1 Introduction

Since Orlikowski and Scott's call for studies that address the "constitutive entanglement" of the material and the social [1], the concept of *sociomateriality* has gained momentum in the information systems (IS) literature, and constitutes by now a significant "wave of research" [2]. The term has, in the other variants "socio material" or "socio-material", been around for a long time. In 1979, Østerberg and Vale [3] explain "sociomatter" as consisting of "human beings and things in a useful context". While Østerberg and Vale's analysis is on the level of society and the crucial distinction between those who own ("matter" and consequently lives in a "sociomaterial society") and those who do not own, another even earlier stream of research focused on the role of technology in organizational change. Socio-technical theorists argued already in the 1950s that technological change implicated both the material and the social [4].

By building on these early insights on the relation between technology and organization, IS research has long recognized the importance of both the material and the social aspects of the human-technology relationship. Ample empirical evidence shows the way new technologies alter the “social dynamics” of organizations [5], be that change in organizational structures, decision-making, and power relationships in formal organizations [3], or change in informal communication networks [6]. Seminal work by Orlikowski [7] indicates technology as a crucial amplifier for restructuring organizations. The other way around, research also documents that technology is not “written in stone”, and rather shows the malleability of technology, explaining how technologies emerge as products of a social process; negotiations, human agency, and personal interest [8]. Information systems, when put in use, are also subject to a great deal of local workarounds, improvisations, and tinkering [9].

The bi-directional relationship between the material and the social is properly established. But we have as of yet not revealed all of its subtle nature; “what is lacking is a satisfactory account of the interwoven relationship between IT and organizational transformation (...) we need to learn more about *how* this interplay works, not only that it exists” [10:326] and resolve “the epistemological and ontological nature of the relationship between the material and the social” [8:160]. The research wave on sociomateriality aims to do just that.

In this paper we report the first findings from our systematic mapping study of the growing body of literature on sociomateriality. Our motivation to do such a study was that in order to release the potential explanatory power of sociomateriality we need to have a base definition and understanding of the term. To do so, we explored how sociomateriality is used in empirical studies. Currently, the debates range from some characterizing sociomateriality as simply (yet another) fancy academic word for technology, to others treating it as a de facto theory of human-technology relationships. We have no wish or intention on concluding this debate. Rather through a systematic mapping study of the body of literature, we aim to add to Leonardi’s initial definition of sociomateriality [11] (see section 2). We do so by inductively deriving three possible themes (or *facets*) characterizing empirical sociomaterial research that should be part of the future sociomaterial discourse and form parts of a base definition that can bring more understanding to the field.

This work does not aim at taking sides in a debate on sociomateriality. We are not arguing in favor or against the need to take a sociomaterial approach rather than building on different research agendas. Rather, we register that a growing body of literature in IS subscribing to this approach, and therefore we make an effort to depict its characteristics and implications. We are aware that other strands of research are also looking at the same challenges (e.g. materialist theories and technology studies in feminist technoscience – see e.g. [12]) with different terminologies. However, for the purposes of this review we chose to focus on the literature that explicitly addresses sociomateriality within the IS field.

The rest of this article is organized as follows. In section 2 we explore the origins of sociomateriality, its status, and explain the rationale for studying it. In section 3 we introduce the systematic mapping method we use in our study, and how we through a 5-step procedure with defined exclusion/inclusion criteria went from a total of N=937 studies to N=51 studies subject for analysis. In section 4 we analyze the studies and map out three facets that are emerging in the literature: *mutuality*, *performativity*,

multidimensionality. Finally we conclude with some considerations on future research directions.

2 The Sociomaterial Rationale

Arguably being at the center of IS attention, explaining the relationship between the social and material is an intriguing challenge, but it has proven to be a difficult one. The same way that socio-technical theorists soon began to focus purely on social interventions [4], working on explaining the nature of the sociomaterial relationship has led researchers to tilt towards either focusing on the social (organization and process) or the material (technology and other objects). Leonardi and Barley [8:160] suggest that the reason for us tilting in either direction is because we “conflate two important but separate, philosophical distinctions: the difference between determinism and voluntarism, on one hand, and the distinction between materialism and idealism, on the other.” The challenge at hand then is to acknowledge that materiality matters, while still assuming that humans perform agency and execute free will, and that this can and is used to also shape and form the material.

Sociomateriality has gained popularity by challenging the separation between technology, work, and organization altogether. Contractor et al. [5] sees sociomateriality as an “analytical break” that can help us avoid the dichotomy that exists between the social and the technical. A sociomaterial understanding “... asserts that materiality is integral to organizing, positing that the social and the material are constitutively entangled in everyday life. A position of constitutive entanglement does not privilege either humans or technology (in one-way interactions), nor does it link them through a form of mutual reciprocation (in two-way interactions). Instead, the social and the material are considered to be inextricably related – there is no social that is not also material, and no material that is not also social.” [ibid., p. 41].

Many scholars have contributed to the understanding leading up to the notion of *sociomaterial constitutive entanglement*. Crinson [13] explains how Orlikowski [14] in formulating the sociomaterial agenda builds on Latour’s actor-network theory (ANT) [15], Knorr-Cetina’s concept of object-centered sociality [16], Bijker’s concept of sociotechnical ensemble [17], Law’s concept of relational materiality [18], and Beunza et al.’s concept of material sociology [19]. The ANT affiliation of sociomateriality is also established by Björgvinsson et al. [20:102] explaining how “these kinds of socio-material assemblies that Bruno Latour so strikingly has characterized as collectives of humans and nonhumans”. However, ANT is grounded on the assumption that humans and nonhumans pre-exist the establishment of collectives. There is a fundamental ontological distinction with e.g. Karen Barad’s notion of agential realism [12], where humans and nonhumans do not pre-exist, but are rather constituted as the entanglements are configured. Matter therefore becomes an active agent in that, by materializing, it performs an action.

Barad [12] explains how the observation of the constitutive entanglement between phenomena and material arrangements influence research on sociomateriality, but she also notes that most of sociomaterial empirical work has focused on the constitutive entanglement of computers and work, as postulated by e.g. Suchman [21].

As intriguing as it may be to study, analyze, and theorize within the sociomaterial research stream, it is a tall order no doubt, to not only bridge determinism and agency, and the material and social, but to build a new understanding where social and material are “*constitutively entangled*”, becoming sociomaterial ensembles (paraphrasing Bijker [17]). The challenging nature of the task has led to ontological confusion [11] where the terms sociomaterial and socio-technical for instance have been used interchangeably, and the term sociomaterial has been used to simply signify that there is a bi-directional relationship without properly exploring it. Taking a first step towards finding a clarification, Leonardi [ibid.] suggests a “rough and tentative” glossary of terms that aims to “...begin a movement in the direction of clarity so that scholars use the terms productively to theorize the complexity of collective endeavors, generally, and organizational dynamics specifically”. In particular, Leonardi differentiates a socio-technical system from a sociomaterial one. The former is defined as the “recursive (not simultaneous) shaping of abstract social constructs and a technical infrastructure that includes technology’s materiality and people’s localized responses to it”. The latter is instead characterized in terms of the “*enactment* of a particular set of activities that meld materiality with institutions, norms, discourses, and all other phenomena we typically define as “social.””

Taking such first steps towards ontological clarity is certainly a prerequisite to theorize. But as Constantinides and Barret [2:291] explain: “there is still the problem of how to study the constitutive entanglement of the social and the material; where does one start, methodologically and analytically, to trace the entanglement”. The diverse origins of sociomateriality, the first attempts at definitions of the term, and the greenfield area of methodology and analysis taken together is what motivated us to do a systematic mapping study of this emerging research field.

3 Method

3.1 Systematic Mapping

To the best of our knowledge (we have searched and talked to experts), no systematic mapping study has been undertaken on the topic of sociomateriality. The systematic mapping method we have applied is a combination of a literature review as known in the IS field [22, 23] and a systematic mapping process. The latter is a protocol known from the domain of software engineering [24]. The stages of the methodology are the following: first we defined the research question. Based on that, we set a search string and query a selection of major databases available online. We then selected articles through a set of defined steps by applying predefined exclusion criteria. For the sake of traceability, we created separate EndNote database at each step. See Fig. 1 for an outline of the process steps and outcomes (figure adapted from Petersen et al. [24]).

3.2 Definition of Research Questions

Our main goal is that of gaining a clearer overview of the evidence around sociomateriality. We therefore seek to answer the following broad research question: *What is empirically known about sociomateriality?*

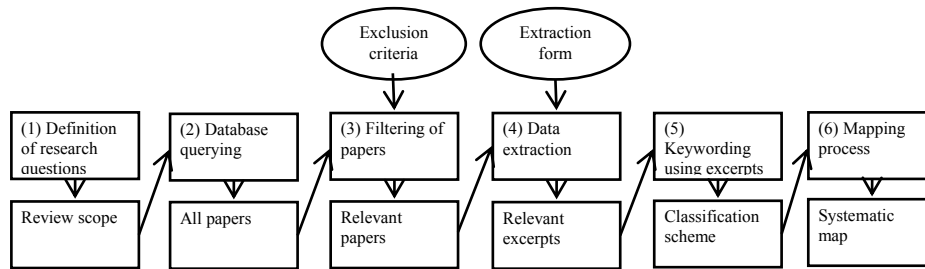


Fig. 1. The systematic mapping protocol applied.

3.3 Database Querying

Based on our research question, the following search string was defined: *sociomaterial* OR "socio-material*" OR "socio material"*, to fetch all the literature addressing sociomateriality.

We adopted an open search to find all articles addressing the topic. Titles, abstracts, keywords, and full texts were searched. We chose a range of well-known scholarly databases from the list provided by Levy and Ellis [23], in order to include contributions from all relevant IS journals and conference proceedings (see Table 1). We selected all the conference and journal papers published until 01.01 2013.

Table 1. Online source and number of articles retrieved.

<i>Source</i>	<i># of results</i>
ISI Web of Knowledge	114
AIS Electronic Library (AISeL)	121
JSTOR	193
ProQuest - ABI/INFORM	283
ScienceDirect	179
SpringerLink	152
TOTAL	1042
TOTAL after duplicate removal	937

3.4 Filtering of Papers and Data Extraction

From the results of step 2, we manually analyzed the article set through a sequence of pre-defined steps (see Fig. 2). In step 1, we created an EndNote database schema to collect the titles, authors, reference type, abstracts, and (if available) keywords

resulting from the above search. We gathered a total of 937 entries after we automatically removed duplicate records. At step 2, 3, and 4, we selected papers eligible for inclusion in a process of increasing levels of granularity. We first considered the titles, then the abstracts and finally the full texts. If abstracts were not available, we read the full text of papers.

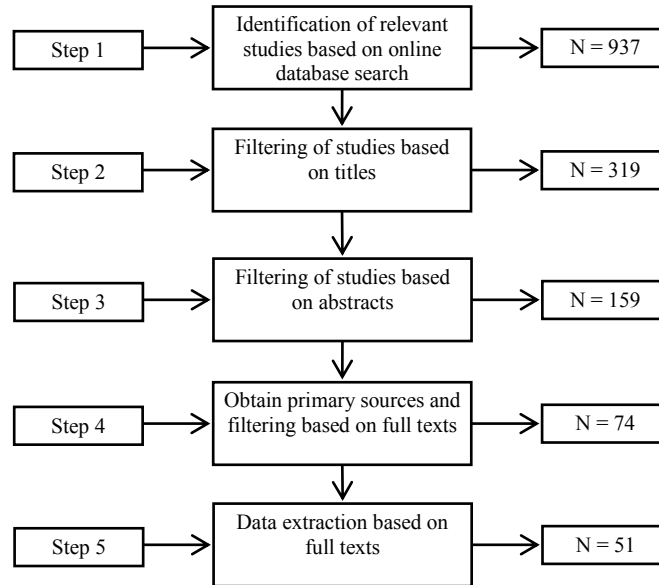


Fig. 2. Steps of the article filtering process (zooming into steps (3) and (4) of Fig. 1)

At each stage, studies were excluded by meeting one of the two following criteria:

- [*Relevance*] Contributions must clearly belong to the research areas of information systems, software engineering, or computer science;
- [*Rigour*] Contributions should provide empirical findings (e.g. by describing case studies) of the concept of sociomateriality. For instance, those studies that explicitly declared to be literature reviews in the abstract or that were lacking a proper paragraph describing the empirical methodology adopted were discarded.

At step 5 we extracted data from 74 studies according to a pre-defined extraction form adapted from systematic reviews in software engineering [25]. This step enabled us to further filter the corpus of relevant articles. While extracting, we applied an additional criterion based on the *relevance* of the studies for the research stream on sociomateriality. We excluded those articles that either:

- Did not provide an explicit definition of sociomateriality;
- OR did not refer to relevant sociomateriality literature in information systems;
- OR did not relate to primary results/findings.

This was done to remove articles that used the term sociomateriality without defining it or pointing to earlier sociomaterial research, indicating that they use the term assuming it to be well understood and agreed upon, or simply as an indicator that the

social and material is entangled (which is known). The outcome of this stage was a final corpus of 51 primary studies.

3.5 Keywording and Mapping Process

Based on data extraction forms, as Webster and Watson [22] recommend, we adopted a concept-centric approach that is likely to better synthesize the literature and thus achieving a mapping framework. We identified a set of concepts by means of a keywording strategy (as discussed by Petersen et al. [24]) applying an open coding technique [26] to the abstracts of the relevant papers found in the previous step. We then clustered the keywords in order to define categories. In line with an interpretivist research tradition [27], our gradual understanding emerged through an iterative creation of categories. To increase validity, the categories were discussed between the two authors and with other members of the research group. The interpretive approach led to a classification scheme – a *systematic map* – made of three facets investigating the *what, how, and where/when of sociomateriality*.

- 1) **Facet 1 – *What***: What definition of sociomateriality is provided? Which theoretical or conceptual backgrounds are leveraged to inform it?
- 2) **Facet 2 – *How***: How are the sociomaterial entanglements understood to perform in practice? What does it mean concretely for researchers to follow up on a case through a sociomaterial lens?
- 3) **Facet 3 – *Where/When***: When and where do sociomaterial assemblages stretch and shape across time and space?

Using these top levels as a map, the relevant articles were analyzed and interpreted into our classification scheme.

4 Results

4.1 Sociomateriality as an ex-post label

As Monteiro et al. assert [28:91] “rather than an independent set of concepts, sociomateriality summarizes and highlights salient aspects and insights gained in information systems research over the last couple of decades”. However, “sociomateriality states *that* use/technology is entangled” (ibid., p. 92, emphasis in original), but not *how*. Along the same lines, Contractor et al. [5:685] state that the sociomaterial approach “does not provide much guidance in specifying how researchers might depict sociomaterial relations empirically”. What is to be searched for is a thorough vocabulary to describe *what* constitutes the entanglements (facet 1); *how* they play out in practice – or perform (facet 2); and *under which circumstances* (facet 3). We therefore divided the primary studies into two metacategories (see Table 2). This revealed that almost 51% of the studies (metacategory 1) are actually using the term “sociomaterial” as an ex-post label. They could be filed under the “nominal” category used by Orlikowski and Iacono [29] to collect those studies invoking the

relevance of the technological element, but not theorizing or conceptualizing it. 49% (metacategory 2) examine the concept of sociomateriality by going further than citing Wanda Orlikowski and Lucy Suchman’s milestone pieces of work [1, 14, 21, 30]. As a result of the keywording and mapping process described in section 3.5, we inductively derived three conceptual categories (facets) and finally grouped the contributions that belong to metacategory 2 accordingly (see Table 3).

Table 2. Distribution of studies on the two metacategories.

<i>Metacategory</i>	<i>Description</i>	<i># of articles</i>
1	Illustrating an empirical phenomenon under the label of sociomateriality.	26/51 (51%)
2	Providing a theoretical or methodological contribution to the understanding of sociomateriality.	25/51 (49%)

4.2 Facet 1: Mutuality – the WHAT of sociomateriality

Mutuality. Baptista et al. [31:172] write: “More recently the IS literature has suggested that as technology becomes more intricate to the functioning of organizations and to the routine behaviors of employees, the social and technical dimensions develop to mutually constitute the ‘sociomateriality’ of an organization [14]. This new conceptualization in IS research has raised subtle but relevant questions, for example about the ontological separation between technology and the social context that influences its use”. Kuk and Davies [32] put a stress on the element of mutuality and define the sociomaterial lens as one that “draws attention to the mutually constituted nature of both human and material agency [33:4], and the roles that social and material artifacts play”. Barley et al. [4] add on to this definition by considering the properties of technology as entangled also with social norms, individual interpretations, and work flows. Riemer and Johnston [34] describe mutual influences in sociomaterial entanglements as a circularity of reference.

Symmetry. Five articles are explicitly grounding a definition of sociomateriality in its actor-network theory (ANT) roots [35, 36, 37, 38, 39], for instance by extensively referring to the work of Bruno Latour or John Law [15, 40]. ANT represents a powerful – perhaps overly exploited – vocabulary at analyzing sociomaterial constitutive entanglements [2, 36, 39, 41, 42]. Al-Mahmood [39] focuses on the Latourian bases of ANT to introduce sociomaterial assemblages as networks of people, nature, and things. In order to underline the relational perspective of a technology, Almklov et al. [9] draw the trajectory of sociomateriality from research in science and technology studies, social informatics (highly inspired by ANT and anchored to Monteiro and Hanseth [10]) towards Orlikowski and Scott [1]’s developments over structuration theory.

Imbrication of agencies. Other studies take Leonardi’s work as a starting point by drawing on his notion of “imbrication” [11], for instance [42, 43, 44]. This concept is more geared towards the role of the interweaving agencies that produce a result (the term is borrowed from the names of the interlocked roof tiles used in ancient Roman and Greek roofs). Imbrications are illustrated as networks of human and nonhuman elements. This aspect is also at the core of the definition of *information*

infrastructures provided by Star and Ruhleder [45], who present infrastructures as a relational concept that emerges in situ through organized practices, a feature explicitly indicated in two studies we retrieved [9, 43]. Adding on the definition of imbrications, Bratteteig and Verne [43] make an interesting attempt at bridging the concepts of “sociomateriality” and “imbrication”. The authors add to the view of sociomaterial entanglement of heterogeneous aspects the concept of “imbrication”, to analytically “disentangle” the knots within sociomaterial assemblages at different levels of complexity. Zorina and Avison [44] instead address the influence of inter-organizational imbrications in Web 2.0 communities. Introna and Hayes [42:120] reshape notions of “formative context” from [46] and “technological frames” from Contractor et al. [5] under the interpretive research tradition and an ANT perspective, to underline how technology and humans constantly frame each other within a sociomaterial nexus: “In our imbrications with technology we are their constitutive contexts as much as they are our constitutive context”.

4.3 Facet 2: Performativity – the HOW of sociomaterial assemblages

Analytical disentanglements. According to Orlikowski and Scott [33] it is possible to untie the knots of sociomaterial assemblages only analytically. Bratteteig and Verne [43] contribute by suggesting a matrix of concepts to solve a sociomaterial entanglement in complex daily situation. But how does the analytical “disentanglement” of sociomaterial assemblages happen in literature? From the previous facet we found a clear emergence of a strong ANT root in how sociomateriality is defined in empirical case studies. Some studies make a step forward by adopting an outlook based on the later versions of ANT. The work by Thompson [37] is relevant in that it uses ANT to explore online work-learning practices. Influenced by Mol [47], the author describes the different ways through which learning practices are enacted thanks to heterogeneous “socialities” and “materialities” that however lead to the same final outcome. Introna and Hayes [42] subscribe to the interpretivist tradition that sees a co-constitutive relation between the context as a whole and the parts as the “texts”. According to these authors, it is however fundamental to underline how technical elements are not necessarily “texts” to be studied with a “context” made of human values and assumptions. This complies with Latour’s claim that there is no clear-cut distinction between subjects and objects. A subset of the primary studies that we took into consideration contribute by figuring out the role of elements that are neither strictly human nor technical, but have been often taken for granted or left lingering in the background in previous literature. For instance, a few studies underline the role of norms [48], human motivations in action [32], historical and cultural traditions [42], local/global contingencies [35, 48, 49].

The performativity of sociomateriality. So far, we have tried to delineate how literature addresses the elements of a sociomaterial assemblage. However, one of the tenets of sociomateriality is performativity, explained by [21] as the enactment of a specific configuration of a reality. A few articles explicitly address the *performative* aspects of sociomaterial entanglements [2, 9, 28, 32, 50]. Monteiro et al. [28] dismiss a representational view of the entangled technological elements in favor of a performative one: the relevance of this piece lies in its provision of a set of labels to

depict the practices through which the operators of an oil and gas company cope daily with the entangled representations of the ICT elements. The same perspective is also adopted by Almklov et al. [9], that show how technologically-enabled representations are actually the result of empirically driven representational practices rather than passive readings of sensors. The information modeling activities, together with the role of experience, are finely illustrated as pragmatic sociomaterial construct that emerge in practice. Another interesting contribution is given by Kuk and Davies [32] in a study following the process involved in the liberation and use of Linked Open Data. Open Data are seen as having their intrinsic value that emerges through the practical interlocking of both human and artifact's agency. The authors argue how not only the performativity of artifacts (e.g., Open Data themselves), but also human motivation can be leveraged to drive innovation in public services. A novel approach to address sociomaterial entanglements in practice is proposed by Constantinides and Barrett [2], who adopt a methodology based on narrative networks to investigate the multiple possibilities of enacted coordinated practices.

Empirical methodology: data collection. A sociomaterial perspective can be innovative at least at two different levels: as a theoretical concept and as a research method. The choice of a specific research design affects the way the researcher is able to account for the performativity of an object of study as a sociomaterial assemblage in its unfolding. One of the emerging characteristic of the empirical studies conducted with a sociomaterial approach is the way data collection is carried out. All the contributions we found were designed as qualitative case studies, mainly based on ethnographies. As such, they mostly rely on interviews, documentation, and observations. In addition, we registered an emerging variation in the typologies of data retrieved. For instance, Kuk and Davies [32] consider Twitter messages in their analysis of the development of Linked Open Data. Al-Mahmood [39] and Van Osch and Mendelson [51] take instead multimedia into account.

4.4 Facet 3: Multidimensionality – the WHERE and WHEN of performativity

A number of studies among those that we gathered also contribute to the notion of sociomateriality by expanding the concept along the dimensions of time and space. The motivation for this shift follows directly from the analysis of the practical performances of sociomaterial assemblages.

Local vs. global. In most of the cases found in the primary studies, the observed empirical phenomenon is a longitudinal stretching of work practices. Observations often unveil that modern work flows are spanning across several geographical locations but must follow either too generic or context-specific norms and process models [42, 49], and are ultimately performed through situated, ad-hoc local practices [2, 35]. The result of these observations is that a continuous “bouncing” effect is created between local and non-local (or global) concerns and the sociomaterial entanglements are therefore augmented not only along the space dimension, but also that of time. Among the studies trying to provide an explanatory framework to this further complexity is that by Nicolini [38]. Here, the author presents a lexicon (based on zooming-in and zooming-out practices) for “recursively navigating between local instances and their connections” (p. 1412). Zorina and Avison [44] argue for the need

to address the external context of inter-organizational imbrications to understand contemporary organizations. In his application of the narrative-network approach to the analysis of sociomaterial assemblages, Constantinides and Barrett [2] demonstrate how different interconnected practices can be traced in time and space. Johri [35] uses the concept of “*sociomaterial bricolage*” by gathering Orlikowski and Scott [1]’s definition and that of *bricolage* [46] as a perspective to understand situated routines during location-spanning work practices. Other studies set instead the magnifying lens on the unfitting of social and technical assumptions inscribed with a model or a technology, that thus struggle to adapt to either local emerging realities or to more global factors. Introna and Hayes [42] tell how the development of a software to detect plagiarism within British educational institution misinterprets the learning habits of Greek students (geographical dimension) that are due to their studying practices traditionally developed (time dimension) in their home country. Monteiro and Rolland [49] specifically tackle the space dimension by introducing the concept of commensurability, to trace the similarity between trans-situated sociomaterial practices. Along the same lines, Monteiro et al. [50] analyze how similarity between technologically mediated work practices is achieved as a political, pragmatic, and performative process.

Table 3. Overview of the studies in metacategory 2 and the facets they present. Relevant features in brackets.

<i>Article</i>	<i>Facet 1 (What)</i>	<i>Facet 2 (How)</i>	<i>Facet 3 (When/Where)</i>
Constantinides and Barrett [2]	x	x (performativity)	x (narrative networks to trace in time and space)
Contractor et al. [5]	x	x (multidimensional networks)	
Almklov et al. [9]	x	x (performativity of representations and models)	
Orlikowski [14]	x	x	
Monteiro et al. [28]	x	x (performativity)	
Kuk and Davies [32]	x	x (performativity; Tweets as data)	x (Case study: Linked Open Data)
Johri [35]	x (ANT and other)	x	x (sociomaterial bricolage; local vs. global)
Gasson [36]	x (ANT)	x (political attachment and local group mobilization in misalignments)	
Thompson [37]	x (later ANT)	x (performativity of learning practices)	x (Case study: online learning)
Nicolini [38]	x (ANT and other)	x	x (zoom-in/zoom-out)
Al-Mahmood [39]	x (ANT)	x (multimedia as data)	x (online learning; spaces emerging relationally)
Awazu and Newell [41]	x	x (knowing through practice)	x (implementation as cultural and historical practice)
Introna and Hayes [42]	x	x (historical and cultural traditions)	x (global practices vs. local contexts)
Bratteteig and Verne [43]	x	x (entanglements + imbrications)	
Zorina and Avison [44]	x		x (inter-organizational imbrications)
Leclercq et al. [48]	x	x (norms)	
Monteiro and Rolland [49]	x	x (performativity)	x (trans-situatedness)
Monteiro et al. [50]	x	x (performativity)	x (family resemblance of distributed practices)
Van Osch and Mendelson [51]	x	x (multimedia as data)	x (Case study: multimedia)
Orlikowski [52]	x (materiality as scaffolding)		
Osterlie et al. [53]	x	x (dual materiality; knowing emergent from different levels of materiality)	
Baptista et al. [31]	x	x (institutionalization of technology)	
O’Farrell et al. [54]	x		
Riemer and Johnston [34]	x (circular reference)		
Svahn et al. [55]	x		

Settings of case studies. The shift to the performative nature of practices entailed by sociomateriality leads to the re-definition of the traditional concept of “space” as

commonly conceived in longitudinal case studies. Typical case studies in the information system literature have been carried on inside organizations – or hospitals – within working settings. Even though the majority of the studies we gathered are still oriented towards the workplace, a relevant discovery of our review is the widening spectrum of heterogeneous cases that scholars have recently started to follow. A sociomaterial perspective seems therefore to enable the enlargement of the research scope to scenarios that were previously ignored. For instance, Kuk and Davies [32] conduct an ethnography of the data liberation process by the British government, and of the way hackers got hold of the data to trigger a process to turn them into Linked Open Data. The Web 2.0 is also emerging as a natural scenario for adopting a sociomaterial lens. Scott and Orlikowski [56] aim to understand what they call the “sociomateriality of accountability” in the context of social media, specifically the TripAdvisor website. The learning experience of workers through online communities is investigated by Thompson [37], whereas Nicolini [38] addresses the field of telemedicine. Sociomaterial interactions embedded in multimedia technologies are also addressed by Van Osch and Mendelson [51] within a community and a primary school.

5 Discussion and Concluding Remarks

There is a long tradition among sociotechnical scholars to acknowledge the role of technologies within society and in particular organizations. *Sociomateriality* emerged as an agenda to gather the streams of research aiming to account for the emergent interplay between social and material aspects. We queried six major online scholarly databases to retrieve articles providing and discussing empirical findings related to the concept of sociomateriality. After a filtering process, we were left with 51 primary studies. 25 of them were considered to go beyond acknowledging the entanglement of the social and the material and to flesh out the conceptual and analytical details of sociomateriality. Our analysis yielded three main facets to outline the emerging core characteristics that extend the tentative glossary of terms by Leonardi [11]. From a first analysis of the attributes of the three facets, we derive the following connections with adjacent IS research streams.

First of all, the key feature of sociomaterial assemblages is their *performativity*. Subscribing to a sociomaterial agenda means addressing them as emerging in practice within a specific context. Actor-network theory (ANT) has provided a powerful vocabulary to do this, by ad-hoc opening or closing the black boxes inside an actor network. Researchers applying this perspective draw on a long tradition of acknowledging the importance of describing assemblages (or actor networks) through their performative stance. Such appraisal is keen on recognizing the malleability of materiality and the workarounds enacted by humans in situated settings and has therefore a consequence on the way the elements of an assemblage are treated analytically (see facet 2). However, studies that are taking this view tend to drift along the peculiar symmetry that the first ANT imposes on the elements of an actor network, by bringing social and the material elements to the same level (see facet 1). The tendency to foreground the role of the technological element is, at least partly, in

line with the arguments raised almost two decades ago by Monteiro and Hanseth [10], and a few years later by Orlikowski and Iacono [29] and Orlikowski [52] asking for a deeper comprehension of the specific role of technology and more in general of materiality in order to understand how knowledge flows within organizations. The few studies that are able to adopt the insight of the later versions of ANT [47] better account for the mutable interplay between more or less visible actors and their relationships distributed in time and space.

Second, sociomateriality has also consequences on the *design of empirical research*, in terms of the settings where studies are conducted (facet 3) and the data collection process (facet 2). ANT-based perspectives still play a major role, primarily due to ANT being a more mature theoretical scaffold that has been evolving during the last 30 years. Researchers adopting an ANT outlook are thus more accustomed to its tenets. Moving forward, we depicted the recent shift from workplace-oriented case studies towards more heterogeneous settings, embracing e.g. multimedia and social networks (facet 3). It is a recent trend registered in literature also outside the scope of our review, see for instance Nardi's ethnographies of online gaming practices [57], Knorr-Cetina's study on the encounter between energy physics and molecular biology [17], and Barad's account for social and natural meanings in the universe [58]. The acknowledgement of the performativity of an assemblage broadens the notion of "space" from the physical location to encompass virtual or distributed settings. In addition, what is considered as *data* has expanded, to include e.g. messages on social networks and multimedia. Indeed, the adoption of a sociomaterial lens implies the need to reconceive the understanding of "objects" (also when intended as technologies). This is consistent with Barad's claim that materiality does not always equal computers, as the IS field has traditionally related to workplace settings [58]. The notion is compatible with that of the Internet of Things, intended as networked heterogeneous devices and tools. This wider view underscores the role of context: each artifact is applied inside different material and cultural practices [29].

Third, the definition of sociomateriality provided by Leonardi [11] is very close to that of information infrastructure [10]. The latter is indeed characterized by features that go beyond the technology and stretch at different practical, institutional, and organizational scales with different temporal concerns [59]. A sociomaterial account might offer a tool to embrace these elements if it successfully applies all the facets outlined above. This is in line with the recent literature in IS. For instance, Barley et al. [4] call for an improved temporal and spatial understanding of workplace technologies, often too bound to the implementation and design dynamics. Karasti et al. [60] also demonstrate how the long-term matters are equally important to the short-term one. By exploring the temporal dimension (facet 3), sociomateriality focuses on how knowing in an information infrastructure is not only a situated performance, but also emerges as a performative accomplishment. It arises from the interplay between particular configurations of not only material phenomena, but also the material arrangements set up by humans to discover these phenomena and the knowledge practices established in time [53].

We have in this work taken another step towards a definition of the sociomaterial agenda. Our mapping of emergent concepts suggests that future studies should focus on aspects of mutuality, performativity, and multidimensionality. Then they will provide a base to account for how associations of humans and nonhumans are

dynamically articulated [61]. In so doing, sociomaterial studies can be relevant also towards notions from agential realism and feminist technoscience.

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