What is 'Information' Beyond a Definition?

Completed Research Paper

Sebastian K. Boell
University of Sydney Business School
Sydney, NSW 2006, Australia
sebastian.boell@sydney.edu.au

Dubravka Cecez-Kecmanovic
UNSW Australia Business School
Sydney, NSW 2052, Australia
dubravka@unsw.edu.au

Abstract

The need to further conceptual engagement with information has been raised repeatedly over the last forty years. Approaches to understanding information in Information Systems have so far focused on defining what information is. In this paper we propose a fundamentally different approach. Using Wittgenstein's philosophy of language we develop a descriptive theory of information. Reviewing how information is used and what it is used for in the literature we state two claims about information: (1) information is used to describe intended information, potential information and information-in-use; (2) different facets of information can be described in relation to pragmatic, semantic, semiotic and empiric aspects of signs. This descriptive theory of information offers an alternative understanding of information for researchers, practitioners, and educators. Our research provides a first step for an alternative approach to information that is grounded in a non-representational understanding of language where words do not have definite meanings.

Keywords: Information, Description, Definition, Descriptive theory, Wittgenstein, Semiotics, Philosophy of Language, Stamper

Introduction

Information is clearly a defining concept for the *Information* Systems (IS) discipline as is reflected in the conference theme for ICIS 2015 'Exploring the information frontier' (Browne et al. 2015). The importance of information as a central concept for IS and the need to engage more thoroughly with information was voiced several times over the last few decades (e.g. Boland 1987; Checkland and Holwell 1998; Churchman 1968; Stamper 1985; Mingers 1996). Nevertheless, since the field of IS started to emerge more than 40 years ago (Hirschheim and Klein 2012) little progress has been made in conceptualizing information, while information technology (IT) has progressed immensely:

> "The explosive growth of information technology has not been accompanied by a commensurate improvement in the understanding of information. It is undoubtedly easier to manufacture and distribute electronic hardware than to refine our concepts of information and disseminate them to the hard-pressed men and women who are trying to put the new technology to work in government, industry and commerce," (Stamper 1973:1).

While these words can be seen as reflecting what is happening in 2015, what is more striking is that this assessment was uttered more than forty years ago. It is therefore fair to say that advances in the conceptual understanding of information have not kept up with advances in IT.

Still, some progress was made over the last four decades and there are now several attempts at defining information. Some define information in terms of data, such as seeing information as processed data (Ackoff 1989) or as data that is selected and relevant for a purpose (Checkland and Holwell 2006). Others define information in terms of knowledge that is made explicit (Tuomi 1999) or as the result of applying knowledge to data (Kettinger and Li 2010). Further approaches define information by separating

information from meaning (Mingers 1995, 2010) or by defining information in terms of a subjective knowledge change (Boland 1987).

Nevertheless when used in IS research, information is often taken for granted and an understanding that conflates information with data is dominant (Lee 2010; McKinney and Yoos 2010). For instance, research interested in the quality of data tokens stored by IT systems uses the terms 'data quality' and 'information quality' interchangeably (Neely and Cook 2011). It seems therefore that there is no clear understanding of what information is and how it may be different from data. There is therefore a clear need for IS to continue its efforts in advancing and clarifying its conceptual understanding of information.

In this paper we argue that in order to advance conceptual engagement with information we need to fundamentally rethink our approach for understanding information. Lack of progress in understanding 'what information is' is not due to a lack of effort seeking to define what information is, but is due to the lack of clarity in the idea of seeking to define information in the first place. As others have argued what 'information' is cannot be captured by a definition (Frohman 2004; Nunberg 1996). This does not mean that we cannot develop a deeper understanding of what information is—to the contrary—it means that we need to let go of the idea that only a sharp definition of information can provide a better understanding.

We therefore offer a new approach to information that is based on descriptions of how the concept of information is and can be used. We refer to the late Wittgenstein (1953) who argued that the inability to define some words is not due to a lack of knowing their real definition, but because there is no real definition. Following Wittgensteinian approach we aim to develop a descriptive theory of information and thereby start a process of thinking differently about what information is and how it can be conceptualized and researched.

To achieve our aim we engage with existing definitions of information and show that they are based on a representational understanding of language. We argue that (late) Wittgenstein's non-representational philosophy of language offers an alternative approach for critically assessing the literature on information. Instead of defining what information is we examine how information is used and what it is used for. Following this approach we develop two claims about information. The first claim differentiates three different descriptions of information: intended information (what is stored by IT), potential information (what is retrieved from IT) and information-in-use (what is actually used in a particular context). In the second claim information is related to signs and described by the aspects of pragmatics, semantics, syntactic, and empirics, each of which include different 'facets' of information. These two claims together with articulation of new concepts to describe information contribute to a 'descriptive theory of information' that is grounded in a non-representational view of language.

Background

In the field of IS, information is often conceptualized as part of a hierarchy "data-information-knowledge" that is sometimes extended with wisdom. This hierarchy – which is frequently abbreviated 'DIKW' – sees data as leading to information, which, in turn, leads to knowledge and then wisdom. This conceptualization of information, commonly credited to Ackoff (1989), is the most prevalent approach to information in IS textbooks (Rowley 2007). The relationship between the different levels of the DIKW hierarchy is generally described as increased levels of understanding or increased order (Bellinger et al. 2004; Rowley 2007). Thus the foundation of DIKW is data upon which the other levels of the hierarchy are built (Fricke 2009; Rowley 2007):

> "Information is contained in descriptions, answers to questions that begin with such words as *who, what, where, when,* and *how many*. Information systems generate, store, retrieve, and process data. In many cases their processing is statistical and arithmetical. In either case information is inferred from data," (Ackoff 1989:3, emphasis in original).

Information is thus defined in relation to data, often conceptualized as 'processed data' that is endowed with meaning, e.g.: "Information is processed data that is meaningful" (McLeod and Schell 2007:9). This of course begs the question what type of, or how much processing is required for converting data into information (Brier 2004, 2008; Buckland 1991). Furthermore, the DIKW approach to information is offering no explanation as to how the same data can lead to different information (Kettinger and Li 2010). Different organizational members, such as accountants, lawyers or managers, having different

background, knowledge and skills are likely to interpret the same data differently and thus can come to vastly different conclusions (e.g. Faÿ et al. 2010). As Boland (1987) highlights, information will differ from individual to individual:

> "Information is an inward-forming. It is the change in a person from an encounter with data. It is a change in the knowledge, beliefs, values or behavior of the person," (Boland 1987:363).

Information therefore needs to be regarded as contextual where the meaning of data is not simple objective answers to questions such as 'who, what, where, when and how many'. Beynon-Davies (2009) subsequently defines information as "information is data plus sense-making" (p. 6). Or to state it differently, information depends on and cannot be separated from the answers that are to be inferred from particular data. Checkland and Holwell's (1998, 2006) therefore conceptualize information as data that is selected – something they label 'capta' – and meaningful in a context:

> "Having selected, paid attention to, or created some data, thereby turning it into capta [...] The attribution of meaning in context converts capta into something different, for which another word is appropriate: the word 'information' will serve here," (Checkland and Holwell 1998:89-90).

Checkland and Holwell, therefore, offer an explanation for why information derived from the same data can be different for individuals and across contexts. However, they conceptualize information as part of a linear relationship in the form of data–capta–information–knowledge. In other words, Checkland and Holwell (1998, 2006) and the other conceptualizations of information discussed so far assume information to be leading to knowledge while being in its existence independent of knowledge.

However, devising approaches for processing or choosing data requires knowledge. A decision to select sales for a specific product category in a particular region for operational or strategic decision making is based on knowledge of, for example, regions and products. It follows that information must be dependent on both data and knowledge, as "data alone cannot 'carry' information" (Langefors 1980:17). Building on Langefors' (1980) work, Kettinger and Li (2010) therefore define information as data interpreted on the basis of knowledge in regard to a particular purpose:

> "*Information* is the meaning produced from data based on a knowledge framework that is associated with the selection of the state of conditional readiness for goal-directed activities," (Kettinger and Li 2010:415, emphasis in original).

While this approach acknowledges the role of knowledge it has one commonality with all definitions of information discussed so far. They all refer in their conceptualization of information to data in a way that sees data as unproblematic implying that data itself are 'objective' (Mingers 1995) or 'raw' (Cole 2008). However, this conceptualization is problematic as data are not given but created. Tuomi (1999), for instance, demonstrate this by putting the argumentation of the DIKW hierarchy on its head. He starts with knowledge at the base, arguing that information is actually explicit knowledge:

> "Information can be created only after there is knowledge, and data emerges as a byproduct of cognitive artifacts that assume the existence of socially shared practices using these artifacts [...] information can be defined as 'anything that can be digitized'," (Tuomi 1999:115).

Stamper (1987, 1991, 1992) offers an alternative approach for conceptualizing information that does not relate information to data or knowledge but instead grounds information in semiotics. Generally, semiotics is the discipline of signs with the latter succinctly described by Peirce (1955) as: "[a] sign [...] is something which stands to somebody for something in some respect or capacity" (p. 99). According to a semiotic understanding of information, information is always expressed in the form of signs. Therefore, a general understanding of semiotics also has important consequences for the understanding of information as information can be described as something that stands to somebody for something in some respect or capacity.

Within the IS discipline, Stamper (1973, 1987) was the first to develop a semiotic understanding of information. Stamper's framework is built on common distinctions in semiotics proposed by Morris (1946) between syntax (the rules of a sign system), semantics (the relation of a sign to meaning), and pragmatics (the purpose of a sign as part of communication). To these three dimensions Stamper added empirics as a fourth dimension. Stamper realized that syntax presupposes that symbols can be differentiated for instance as different letters of the alphabet. According to Stamper, empirics is therefore

interested in distinguishing different signs with a high level of reliability thus providing a link between signs and the physical world (Stamper 1991, 1992).

In contrast to Stamper's semiotic description, Mingers (1995, 1997, 2010) seeks to avoid any problem in defining information by removing information from meaning:

"Information is different from meaning. Information is an objective, although abstract, feature of the world in the same way as are physical objects and their properties," (Mingers 1995:295).

While Mingers' definition of information avoids data, knowledge or meaning it assumes that information is a concrete concept that can be captured by defining it. What Minger's therefore has in common with other conceptualizations of information is that they employ a particular understanding of language to approximate the concept. They approach the concept of information by defining what information is or stands for, thus ascribing a definite semantic meaning to the term 'information'. This implies a particular understanding of language according to which words have a well-defined meaning that can be assigned to them in definitions or poured into them when they are learned. This understanding of language was critiqued by Ludwig Wittgenstein in his later writing as the 'Augustinian' model of language (Wittgenstein 1953). According to this understanding, words stand for specific concepts that, for example, can be learned by pointing at an object and then uttering the word that stands for this object.

A problem however is that information is a 'semantic chameleon' (McKinney et al. 2012) and using the term 'information' enables us to point things out without being forced into making a clear and definite statement. Definitions can therefore be seen as insufficient for describing what information is, as definitions seek to ascribe a definite semantic meaning to information:

"any effort to try to extract a coherent conceptual structure for the notion [of information] would be not just futile but false to its phenomenology: *information* is able to perform the work it does precisely because it fuzzes the boundaries between several genetically distinct categories of experience," (Nunberg 1996:114, emphasis in original).

For instance, information is related to both, what we believe exists in the world (ontology) and how we can gain knowledge about the world (epistemology). The term 'information' therefore implies a "collapse of ontology and epistemology" as ontological information signifies that 'modes of being' are translated into 'abstractions of knowing' and thus epistemology (Lash 2006: 581). However, at the same time, information also signifies that epistemological 'modes of knowing' increase ontological 'modes of being' (Lash 2006). Frohman (2004) thus argues that: "[i]deas of information that enjoy the theoretical rigor of definitions and essences are not useful in understanding the phenomenon of information" (p. 388).

This paper builds on the criticism expressed by Nunberg (1996) and Frohman (2004) and engages with an alternative approach for conceptualizing 'information' that does not seek to define what information is. So far attempts to define what information is and thus ascribe a definite semantic meaning to the concept, have not produced an acceptable and sufficiently flexible conception of information. Instead of continuing on this path (seeking more comprehensive definitions) we suggest taking a radically different approach: to conceptualize information by describing how it is used and what it is used for, inspired by the late Wittgenstein's (1953) approach to language. Describing information by its various usages we begin in this paper the development of a descriptive theory of information. The aim of this paper is therefore to propose a descriptive theory of information that is derived from a variety of ways how information is used in the literature. We envisage that this theory will be developed further as new descriptions of information usage will be added. The descriptive theory of information will enable IS researchers and practitioners to share understanding of what information is based on their experience and in their particular context without being forced into drawing a strict boundary around what information is.

Wittgenstein's Philosophy of Language

Any attempt to define a concept is based on the assumption that words have or should have a well-defined meaning that can be extracted from them in definitions, or poured into them when they are learned. Wittgenstein (1953) critiqued this understanding of language as the 'Augustinian' model of language. According to this understanding, words stand for specific concepts that, for example, can be learned by pointing at an object and then uttering the word that stands for this object. However, this separates a word and concept as being two different things (Blair 2006). In contrast, Wittgenstein argued that there is

no additional layer or meaning beyond a word and how it is used: "[i]t is as if in imagination we put a thing into its own shape and saw that it fitted" (Wittgenstein 1953, §216). Subsequently Wittgenstein argued that the main vehicle of thought is language itself and not meanings: "When I think in language, there aren't 'meanings' going through my mind in addition to the verbal expressions: the language is itself the vehicle of thought" (Wittgenstein 1953, §329).

This, of course, does not deny that one may think in terms other than language, such as spatial imagination, but when one thinks in terms of language, language itself is the main vehicle of thought. This insight that meaning and words are inseparable has important implications for how terminology can be approached and analyzed. In particular, it cautions against the use of definitions:

> "We are unable clearly to circumscribe the concepts we use; not because we don't know their real definition, but because there is no real 'definition' to them. To suppose that there *must* be would be like supposing that whenever children play with a ball they play a game according to strict rules" (Wittgenstein 1958:25, emphasis in original).

Language is fluid and developing where terms have no finite or clear meaning. In contrast, definitions are an attempt to draw a sharp boundary around a term to clearly specify what is included by the term and what is excluded. Wittgenstein, however, questioned the usefulness of such attempts: "[m]any words [...] then don't have a strict meaning. But this is not a defect. To think it is would be like saying that the light on my reading lamp is no real light at all because it has no sharp boundary" (Wittgenstein 1958:27).

Instead, what is of importance is how words are used in communication. Blair (2006) further elaborated on Wittgenstein's account:

> "This is not, of course, an argument for sloppy definitions. It is merely the observation that looking for definitions in this case gets us away from the true foundation of our ability to analyze and classify things like "games" [or information]. By trying to find a common set of properties that we can use to determine set membership, we are guilty of trying to make an 'indistinct picture into a sharp one'" (p. 113).

Fortunately Wittgenstein indicated a way out of this conundrum. Instead of providing definitions, he suggested drawing from examples and descriptions to get closer to understanding a word: "[w]e must do away with all *explanation*, and description alone must take its place" (Wittgenstein 1953, §109; emphasis in original). Consequently, an alternative approach to understanding 'information' is to provide descriptions of the ways in which the concept is used. The Wittgensteinian approach proposed here, therefore, enables us to gain a holistic understanding of what makes something information without being forced into definitions that necessarily lead into an exclusive understanding of information such as the objective content of a sign (Mingers 1997) or the inward forming of a subject (Boland 1987).

Methodology

In order to develop a descriptive theory of information following the late Wittgenstein, we conducted an extensive review of literature conceptually engaging with information within the IS discipline and beyond. In particular we investigated how information is described by these works. In our overview of the extant literature it was important to ensure appropriate breadth and depth of coverage of the literature (Hart 1998). As the relevant body of literature is huge (Bates 2010) breath was of particular importance in order to get a thorough understanding of the wide range of different ways information is used in the literature.

To ensure breath in our coverage of the literature we initially focused on review publications that each provided an extensive conceptual overview on information. Such reviews came from IS (McKinney and Yoos 2010; Mingers 1996) and neighboring disciplines, such as: library and information science (Bates 2010; Capurro and Hjorland 2003); psychology (Collins 2007); philosophy (Floridi 2009; Lenski 2010); the natural sciences (Fischer 1993); information theory (Martignon 2001; Ritchie 1986); computer science (Aspray 1985); and a cross-disciplinary review in communications (Rice et al. 2001). In addition to these reviews, we further broadened our understanding through an extensive glossary of information-related terms published by BITrum (Diaz Nafría et al. 2010) and through the interdisciplinary journal 'Information' established in 2010 (Lin 2010). On the basis of these reviews we sought to identify further relevant research by going 'backwards' following references and 'forward' by looking up citations (Webster and Watson 2002). We thus employed a hermeneutic approach for conducting literature reviews

expanding our coverage of the literature on the basis of our expanded understanding through the literature already identified and read (Boell and Cecez-Kecmanovic 2014).

Our review focused on analyzing different ways in which information is described and used throughout the literature. For our research the literature on information was therefore the empirical material that we subjected to a thematic analysis (Ezzy 2002). We examined claims made about information, when information is described and used. Statements made about information were analyzed in an open coding process resulting into 1st order concepts (Gioia et al. 2013). Through contrasting and comparing commonalities and differences across different 1st order concepts more abstract 2nd order themes started to emerge. For instance, some approaches to information emphasize that information has an effect on actions and decisions (1st order concepts). As a result, 'action relevance' was identified as a 2nd order theme that became one of the facets of information evoked throughout the literature for describing information.

More broadly the second order themes belonged to two dimensions. The first dimension relates information to technology (e.g. capturing and storing) and to use by human actors in a context. Within this dimension we identified that the term 'information' is used to denote three different concepts: 'intended information', 'potential information', and 'information-in-use'. The second dimension relates information to different characteristics that were used to describe how something comes to be seen as information. In particular these descriptions relate to the physical 'carriers' of information, to the rules of sign systems, to individual or collective understanding and to the situations in which information is used. This analysis enabled us to articulate the notion of 'facets of information' and classify them according to the four semiotic dimensions – pragmatics, semantics, syntax and empirics – initially established by Stamper (1987, 1991, 1992). These two dimensions for describing how information is used were derived from different usages of the term information in the literature. However, while these dimensions *describe* how information is used they do not *define* what information is.
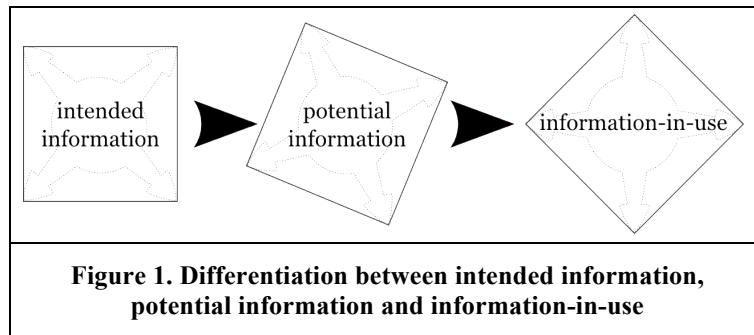
Claim I: Information Refers to Intended Information, Potential Information and Information-in-use

As Boland (1987) pointed out, what is considered 'information' will differ between actors. Different groups of actors operate within varying contexts and areas of expertise thus bringing diverse backgrounds to their understanding of problems and challenges. Every organization of minimal complexity will involve different actors who have different background, training and intentions. For instance, working with the same product a worker manufacturing it, an accountant estimating production costs or a salesperson marketing that product to a customer will regard different aspects related to the product as information to them. Similarly, shop floor managers and central management may conceive different information from the same event (c.f. Faÿ et al. 2010). Shop floor managers may be interested in minimizing sales forecasts in order to safeguard them from falling below expectations; in contrast central management may be interested in maximizing sales forecasts in order to show value to the board and shareholders. Consequently, one group understands events that can have an influence on sales forecasts as information that sales forecasts will continue to grow while another group understands this event as information indicating that sales will decline (Faÿ et al. 2010).

Information as actually used, therefore, can only exist from the position of a recipient who accepts something as information. What a provider of information conveys cannot be regarded as information in itself but only as a proposition for information. Subsequently what is stored into IT systems can only be regarded as intended information. When IT is used, parts of intended information that are stored by IT are reproduced and conveyed to a recipient. This output can then be regarded as potential information that is proposed as information to a recipient. And finally, if potential information is accepted by a recipient and regarded as relevant, novel, and so on (see proposition 2) it becomes information-in-use. This relationship, as displayed in figure 1, allows the development of a deeper understanding of how IT and users are related when information is exchanged. Our first claim is thus:

Ia) The concept of information is used to refer to three different notions – intended information that is (to be) stored, potential information that can be (or is) retrieved and information-in-use that is used as actionable and relevant by actors within a particular situation;

Ib) When we use the term information we have to clearly indicate which particular notion we are referring to.

**Figure 1. Differentiation between intended information,
potential information and information-in-use**

This difference between intended information, potential information and information-in-use becomes a powerful tool for analyzing information exchange mediated by IS when it is combined with claim 2, the facets approach to understanding information.

Claim 2: Information Can Be Described by Facets

Information is often understood as something that stands for somebody in some capacity or regard, which clearly relates information to signs (Beynon-Davies 2010; Stamper 1987, 1991, 1992). Importantly, we understand signs in the widest possible sense to include, but not being limited to textual, graphical, numerical, auditive, or any other types of signifiers. The difference between sigs and information is that not everything that stands for somebody in some regard (a sign) is also automatically information to them. Facets of information therefore describe conditions for signs to potentially be regarded as information. For instance, novelty is not a condition for the existence of signs, but a condition for a sign to become information. Using this approach we can summarize how different authors describe information throughout the literature. Furthermore, as Stamper (1987, 1991, 1992) provides a rich description of information, rather than a definition, it is possible to use Stampers' semiotic approach to further structure a Wittgensteinian description of information. We thus use Stamper's distinction between pragmatics, semantics, syntax, and empirics to classify 15 different facets used throughout the literature for describing information.

Pragmatics

Pragmatic facets relate information to intentions, motivations, interests, goals, practices and so on. Facets of information associated with the pragmatic aspect highlight the importance of the socio-cultural context, social actors and their goals and practices. At the pragmatic aspect, what matters for something to become information is its relevance within a situation (problem solving and action), novelty for a user, time dependence in terms of the dynamics of the situation, trustworthiness and relevance to a particular social practice.

Action Relevance. Information is regarded as relevant and useful for solving problems, enabling taking action or making decisions (Capurro and Hjorland 2003; Checkland and Holwell 1998; Davenport 1997; Fischer 1993; Galliers 1987; Kuhlen 1991; Lewis 1991; Machlup 1983; McLeod and Schell 2007; Steinmüller 1993). Consequently, even a correct answer to a question may not qualify as information if it does not help to address the problem that underlies the question. As Mason and Mitroff (1973) put is: "information is knowledge for the purpose of taking effective action" (p. 475). In the context of IS, the importance of the facet of action relevance of information is evident in the design of ICT components (databases, infrastructure, programs) of an IS capable of producing certain intended information. For example, the way risk is perceived by different members of an organization as something to be taken action upon, will affect how intended information about these risks needs to be captured and stored into a risk management system (Drummond 2011).

Novelty. Several authors have emphasized the facet of novelty for describing what information is (Capurro and Hjorland 2003; Davenport 1997; Kallinikos 2006; Kuhlen 1991; Machlup 1983; Meadow

and Yuan 1997; Nauta 1972). According to this facet something that is already known or understood cannot be information: "In order to be informative, a message [...] must be able to add a distinction and confer something new on what is already known about the world. [...] Conveying something that is already known is to communicate no information" (Kallinikos 2006, p. 101). However, this does not mean that everything that is new will be information (Fugmann 2007) or that information may not require redundancy in order to corroborate different sources (Kuhlen 1991). In this sense receiving the same message from other sources still provides information, for instance, about the accuracy of a report. Zuboff's (1988) notion of 'informating' highlights that the implementation of ICT into organizations is not simply a means for automating, but that ICT facilitate novel potential information that, when transformed into information-in-use can fundamentally alter understandings about an organizational problem.

Time Dependence. Several authors describe information as dependent upon time (Buckland 1991; Davenport 1997; Kuhlen 1991; Meadow and Yuan 1997; Steinmüller 1993). What is considered information at some point in time may not be considered information at another point in time. Conversely, something that previously was not considered relevant or useful may suddenly become considered information. Information is contingent, timely and relative to the situation in which it is used (e.g Goguen 1997; McLeod and Schell 2007). For instance Suchman (1987) looked at how users made sense of instructions provided by the help systems of copy machines. Her case exemplifies how potential information provided by the help system is constantly reinterpreted – thus becoming somewhat different information-in-use – as part of an ongoing troubleshooting process. As a result, what is regarded as important and thus constitutes information is constantly changing.

Trustworthiness. Information needs to be accepted and believed, as something that is not trusted cannot be regarded as information (Introna 1997; Kuhlen 1991; Meadow and Yuan 1997; Rice et al. 2001). Trustworthiness therefore refers to a recipient's trust in the reliability, veracity, credibility, correctness or validity of the content of information as signs. There are two aspects of trustworthiness: one is related to a source in the sense that some sources are trusted more than others, and the other is related to the affective dimension of a person, indicating the importance of confidence, attitude or comfort in regards to information. An example of the former may be statistics published by a governmental institution versus statistics published by a industry body. An example of the later may be that first-hand accounts could be more highly regarded than anonymous comments. Means for improving the trustworthiness in potential information provided by ICT, for instance by indicating where information originated from, can thus facilitate that a system output will become information-in-use.

Social Practice. What is considered to be relevant and valid and thus can be considered constituting information depends on the shared practice of a group of social actors (Kuhlen 1991; Meadow and Yuan 1997; Steinmüller 1993). Criteria for something to be information therefore arise through the interactions of different actors in specific contexts. Goguen (1997) even goes as far as claiming that "[i]nformation can only be fully understood in relation to the particular, concrete situation in which it actually occurs," (p. 34). For instance, different members of an organization, such as lawyers, human resource managers or engineers engage in different social practices and as a consequence will regard different aspects of a same phenomenon as potentially informing them. Intended information provided by an ICT system will thus be considered as providing different potential information depending on social practice within which an ICT system is used.

Performativity. Information is typically related to what is the case in the world thus reflecting a representational view of language. However information can also bring about things into the world. When uttered or computed information can make the world or bring something into existence. Drawing from Austin (1962) we define performativity of information as a facet that describes what information does or performs when used in social practice. For instance accounting IS regularly produce information about costs, income, profit, efficiency, profitability and the like. Profit information does not describe an external reality, instead this information makes a reality (Puyou et al. 2012). To perform a reality information has to be produced by a trustworthy and legitimate source and according to accepted norms and rules in social practice (in this case accounting practice). Performativity of information as a facet applies only to information-in-use and implies conditions shared in the social practice.

Semantics

For something to be regarded as information particular signs used for conveying information need to have meaning. Facets of information in the semantic aspect are therefore related to "the relationship between the signs and the things or events they denote" (Artandi 1973, p. 245). Three facets of information referring to the semantic dimension are used for describing information: comprehensibility, contextuality, and level of detail.

Comprehensibility. For something to be information it needs to be intellectually understandable. The facet of comprehensibility is thus related to the ability to express meaning using signs and also to understand specific meanings of signs used for conveying information (Davenport 1997; Introna 1997; Kuhlen 1991; Mason 1979; Meadow and Yuan 1997; Rice et al. 2001). Something that cannot be expressed by a sender using signs or something that cannot be understood by a recipient cannot convey information. Therefore, comprehensibility of information depends on knowledge, skills and literacy of users. Different recipients and contexts allow different degrees of complexity and sophistication. Information may be easier or more difficult to understand. For instance, different levels of literacy or unequal skills for searching the Web or databases will affect what constitutes potential information and information-in-use for different individuals. Another example is the different comprehension of reports provided by ICT not only regarding their content but also regarding the process of their generation.

Contextuality. Shared meaning and therefore information exchanged through signs depend on a wider social context and a shared historic and cultural background. Information is thus related to a wider sociocultural context and also social practice which determines rules for what can be expressed as information for whom and how (Davenport 1997; Floridi 2005; Goguen 1997; Kuhlen 1991; Meadow and Yuan 1997; Rice et al. 2001). This includes assumptions and beliefs about the world which are often taken for granted among the members of a society or group, such as, shared language, considerations about ethical behavior, or a shared technological understanding. For instance, organizations in different cultural contexts are structured differently in terms of their formal and informal reporting structures. Such differences shape what is regarded as intended information and potential information for different members of an organization when enterprise resource planning (ERP) systems are implemented (Zhang 2011).

Level of Detail. Information needs to be expressed and received (that is, potential information) at a specific level of detail in order to be meaningful (Blair 2006; Brown and Duguid 2000; McLeod and Schell 2007; Meadow and Yuan 1997). A higher level of detail allows more fine-grained distinctions, but more detailed does not necessarily mean better information: "[e]fficient communication relies not on how much can be said, but on how much can be left unsaid – and even unread – in the background" (Brown and Duguid 2000:205). Nevertheless, highly specialized areas will require means that allow experts to draw fine differences. In the context of IS, inappropriate level of detail is illustrated by examples of voluminous ICT responses to queries that restrict users' ability to extract meaningful information from high volume of potential information provided.

Syntax

For something to be considered information, it has to adhere to the rules associated with the sign systems used to express this information. At the syntax aspect facets of information are therefore related to the adherence to structures and rules associated with a sign system. Apprehensibility and precision are two syntactic facets evoked for describing information.

Apprehensibility. Rules of a sign system have to be understood by both a provider of intended information and a recipient of potential information in order for the sign system to be able to convey information to a recipient. Apprehensibility therefore refers to the ability of the users of a sign system to understand these rules (Introna 1997). For instance, an information provider needs to be familiar with Chinese characters so that '八三六九' can convey information in the same way as '8369' can to someone familiar with Arabic numerals. A common example in the context of IS is character encoding where intended information about a customer's name containing an 'Ä' may instead be displayed with something nonsensical such as '　'. Importantly apprehensibility differs from comprehensibility as the former is related to the rules of a sign system and the latter to the meaning derived by a recipient.

Precision. The potential to represent information depends on how specific a sign system is in regard to allowing the expression of certain aspects Sign systems differ in the precision they enable and thus provide limitations regarding the level of granularity in which information can be expressed (Davenport 1997; Mason 1979; McLeod and Schell 2007). In the context of IS, sign systems are the systems used to capture and express intended information via ICT. For instance, databases can be seen as sign systems that syntactically provide specific precision. If a database does not provide an appropriate field for some aspects in the first place, these data cannot be captured by that sign system at all (Weick 1985). Thus, precision provided by a sign system is tied to the ability to convey intended information or to derive potential information from an ICT artifact.

Empirics

At the empiric aspect, signs are bound to a physical medium thus enabling intended information to be stored, communicated and accessed by users. Facets of information at the empiric dimension are therefore related to the physical or material nature of a medium carrying information as signs. Four facets of information related to empirics are described throughout the literature: physical access, detectability, physical inscription, and speed.

Physical Access. Something that cannot be accessed cannot become information, thus for something to become information, physical access to that information is required (Chopra and Dexter 2008; Davenport 1997; Mason 1979; Rice et al. 2001). For instance, intended information stored in a database needs to be displayed in some form so that it can become potential information and subsequently information-in-use. Rice et al. (2001) argue that access includes among other aspects how environmental and ergonomic factors such as secured access can hinder physical access.

Detectability. Something that cannot be differentiated from a background or 'noise', and therefore detected cannot become information (Shannon 1948; Shannon and Weaver 1949; Suchman 1987). Shannon (1948) developed a calculus that allows engineers to determine the degree of certainty with which a signal that is send at one end is detected correctly at the other end by a receiver (Martignon 2001). Generally the reliable transmission of signals is sufficiently covered by engineers developing ICT. Nevertheless detectability as facet of information is important, for instance, when considering access in an environment with particular lighting, background noise, or for people who are blind, visually impaired or deaf.

Physical Inscription. Information is always inscribed into a physical carrier medium with the characteristics of this medium affecting how information can be ingrained into them (Taylor 1986). Durability of a physical inscription determines capacity to convey intended information over time by withstanding physical stress and destruction such as fire. Transportability refers to the ability to transfer information over space. For instance, information on the Web is highly transportable; however, it is also prone to being compromised during this process. For these reasons, the Transmission Control Protocol (TCP) is used to ensure the integrity of the information transported. Physical inscription together with durability and transportability of information can thus be an important facet of information for IS.

Speed. Information depends on the speed by which signs carrying intended information are conveyed to a recipient (Beynon-Davies 2009; Steiner 2012; Taylor 1986). Historically, the list of innovations to physically transport information faster is long, as the speed by which information can be transported has obvious importance for military and business purposes (Wright 2007). Furthermore, by using ICT to perform calculations in a time frame of seconds rather than weeks, what is considered potential information changes and thus augments new possibilities of information (Taylor 1986). For instance, in the case of online trading where shares are sold or bought based on market data, even small fractions of time can make a difference regarding whether something may or may not be information (Steiner 2012).

Summary of the facets of information

Throughout the literature information is described evoking fourteen different facets related to four different aspects of signs (Figure 2). At the pragmatic aspect information is related to intentions, motivations, interests, practices or goals associated with signs, subsequently facets of information are: action relevance, novelty, time dependence, trustworthiness and social practice. At the semantic aspect information is related to the meaning denoted by signs, evoking comprehensibility, contextuality and level

of detail as facets of information. At the syntax aspect information is related to the rules of a sign system linking information to the facets of apprehensibility and precision. And finally the empiric aspect links information to a physical medium where information is associated with the facets of physical access, detectability, physical inscription and speed. Our second claim is thus:

2) The concept of information is associated with different facets linking information to pragmatic, semantic, syntactic and empiric aspects of signs.

Figure 2. Overview of the different facets of information
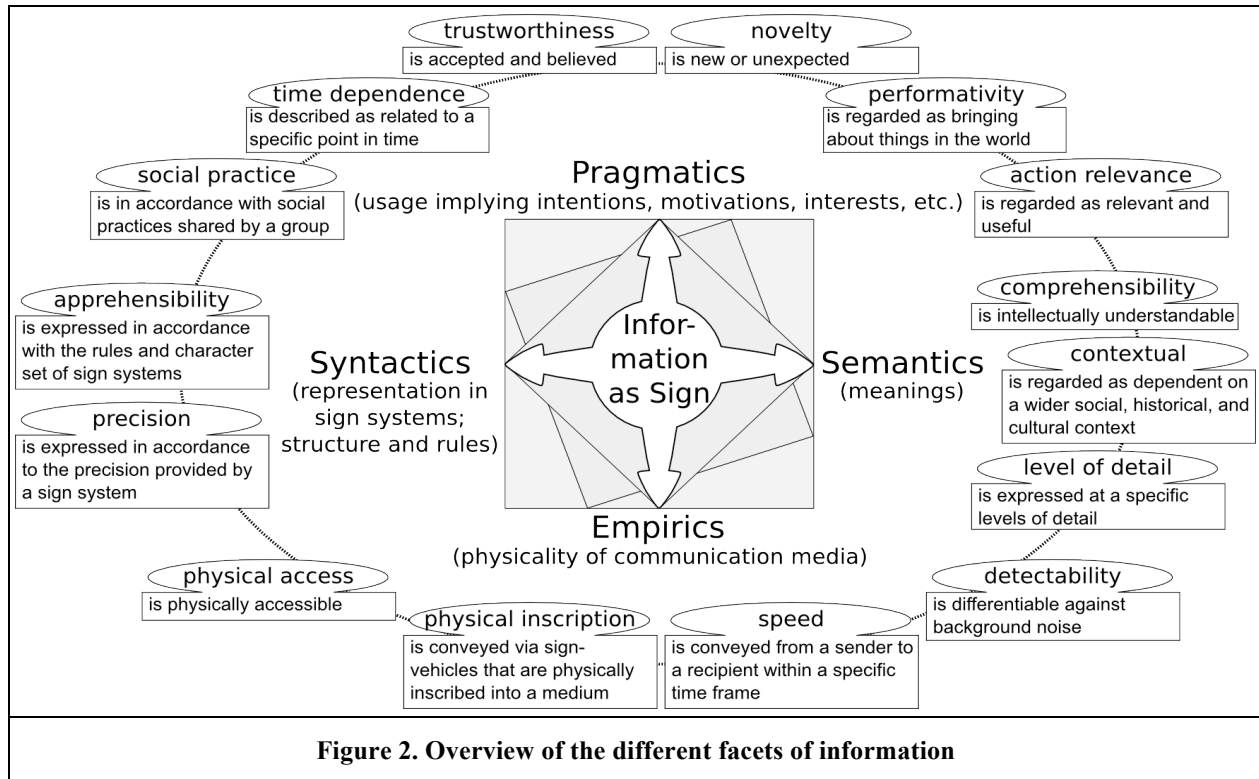
A Descriptive Theory of Information

Our proposed 'descriptive theory of information' describes information along two orthogonal dimensions. The first dimension summarized in clam 1 and figure 1 distinguishes the use of information as intended, potential or information-in-use. The second dimension describes specific facets of information related to the aspects of pragmatics, semantics, syntax and empirics, summarized in claim 2 and figure 2. Without attempting to define what information is, both dimensions, nevertheless, contribute to advance understanding of information by describing how the concept of information is used. These descriptions of information however should not be understood as 'defining' conditions for something to be information. Different facets related to information all contribute to a description of information, for instance, that information has a novelty character or that it is comprehensible. However, facets are not summative in the sense that if different facets of information are fulfilled then something must therefore be information.

Furthermore, the descriptive theory of information approaches the concept of information in a way that overcomes the problem identified by Frohman (2004) and Nunberg (1996) that definitions are insufficient for developing an understanding of what information is. Of course this does not mean that there may not be circumstances when it is beneficial or necessary to define what is understood to be information within a particular situation. However, in itself an attempt to defined information is insufficient for fully conceptualizing what information is. This is so because information as a concept simultaneously relates to two things: *how we find out about what exists* and at the same time information also shapes *what we regard as existing*. The descriptive theory of information therefore expresses that central to the notion of information is that the way in which we know about the world and what we can

know about the world are inseparable (Lash 2006). This means: as understanding of the world is changing through information, so is the understanding of what is, or will be regarded as information. However, when information is defined a particular static meaning is ascribed to the concept of information. Ironically any attempt to define information therefore contradict the notion of information itself, namely that understanding of what things are and how we find out about them is part of an ongoing, evolving process. We thus note that the proposed dimensions that describe information in different ways, by no means, exhaust all possible ways information has been, is or will be used. As the IS field progresses in its engagement and understanding of information new 'information' about facets of information may come to light that support us in our attempt to come to terms with the concept of information.

In addition, the descriptive theory of information can be used to investigate and make sense of IS development and use and of complex transformations in organizations and society emerging from IS use. The descriptive theory of information, therefore, helps in making sense of the world and interrogating reality in order to derive practical imports for both research and practice (Weick 1989, 1995). For instance, by distinguishing intended information, potential information, and information-in-use numerous controversies in IS development and implementation can be clarified and addressed. There is often confusion in practice arising from conflating these usages of the term information. Developers, managers, office workers and other user groups engage in different 'language games' (Wittgenstein 1953) where the 'same' technology is used for different purposes and thus will convey different information. Definitions of information are insufficient for coming to a shared understanding of what is considered to be information within and across different language games. Instead, a description of how information is used within different language games offers necessary flexibility for capturing different nuances of information important within the context of different language games. For instance, IS developers do not always see that 'information-in-use' is inevitably different from intended or potential information. On the other hand IS users often complain that outputs derived from IT are not action-relevant, timely, or appropriate for their social practices. Users expect that intended information (implied while designing data resources) automatically reflect their changing practices and needs. As this exemplifies, the descriptive theory of information can assist in developing shared understanding of continuously changing 'information-in-use' in actual contexts of an organization or community and thus alleviate various problems in IS practice.

Furthermore, distinguishing intended information, potential information, and information-in-use and different facets of information for IS research the descriptive theory of information supports an accumulative research tradition as differences and nuances among conceptualizations of information become clearer. Researchers can use the descriptive theory of information to more easily express their understanding of information and thus build on each other's work by using comparable conceptualizations of information. For example, looking at the facets of information provides a foundation for a better understanding of information exchange as different facets can be used for analyzing information. Applied in this way the descriptive theory of information can help to better ensure the transition of intended information when a system is designed into information-in-use when a system is used in everyday practices. Going through each of the facets related to information can therefore help to improve the match between the information use that is envisaged and the way intended information is stored and reproduced.

An Illustrative Example

In order to illustrate how the descriptive theory of information can contribute to understanding IS development and use in practice we briefly discuss the introduction and subsequent use of a system for Evaluation of Teaching and Courses at Universities (ETCU) (see figure 3). The system was initially designed with the aim of monitoring and supporting continual quality improvement of courses, their delivery and content. At the design stage key decisions were made concerning the content of questionnaires to be administered to students at the end of a course and the content and structure of a database to store this (intended) information. For instance, the questionnaire about the quality of a course included statements like: 'This course has stimulated my interest in the subject matter taught'; 'This course content was appropriate given its objective and the expected learning outcomes'; 'Teaching materials and the textbook were useful and of high quality'; 'Overall, I was satisfied with this course'. The

questionnaire to assess a lecturer included statements such as: 'This lecturer communicated effectively with students'; 'The lecturer was well prepared for the teaching'; 'The lecturer provided useful feedback to help me learn'; 'Overall I was satisfied with the quality of this lecturer teaching'. Possible answers range from 'strongly agree' to 'strongly disagree' on a 5 point Likert scale. And reports were administered on paper. The scores for each course and each lecturer were recorded in the ETCU database. The database thus included information deemed relevant for assessing and monitoring the quality of courses and the quality of lecturers.
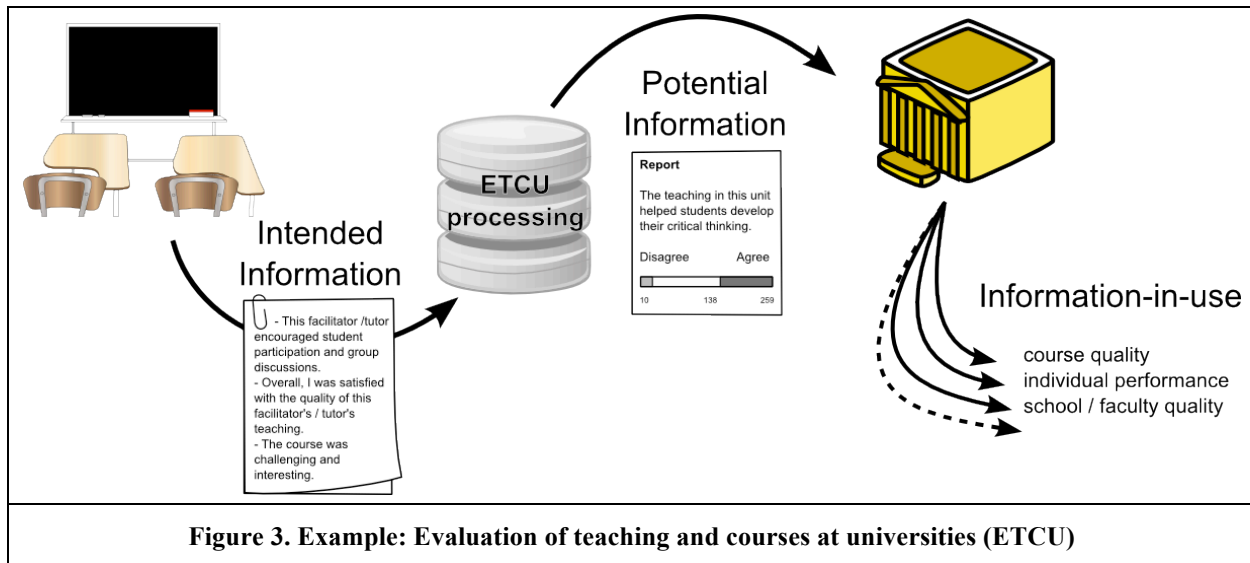

Figure 3. Example: Evaluation of teaching and courses at universities (ETCU)

After each semester the reports were generated by processing information from the ETCU database and aggregating the overall scores for each course and each lecturer. In other words, the intended information contained in the database were transformed into potential information (reports) available to each lecturer. In such a way, each lecturer got feedback from students regarding both their assessment of the course and the lecturer's teaching. As lecturers interpreted these reports, compared them with previous years and made sense of the various aspects of quality as assessed by the students, potential information became information-in-use.

From the above description we can see which particular facets of information became relevant and considered at any point in time. When deciding on intended information (collected from students using a questionnaire and stored in the database) and potential information for staff (reports), the *social practice* of teaching and learning was of primary interest. Given the aim of continual monitoring and improvement of teaching quality, the needs of both students and lecturers were investigated. Related to this is the *action relevance* of potential information: how useful and actionable are information provided in summary reports (and transformed in information-in-use) for staff. For reports to be actionable they had to include all relevant quality assessment aspects so that staff can make sense of the quality of the course and their teaching from the students' perspective. Furthermore, these reports had also to be timely so as to allow staff enough time to take action and improve the course and their teaching (delivery), suggesting the relevance of the facet of *time dependence*. The facet of *novelty* in this example shows that potential information may not necessarily be novel – when they confirm for instance a high quality course and a high quality teaching – but would still be of high importance for staff. Finally, the facet of *trustworthiness* of information (reports) is not explicitly considered but implicitly assumed. Being responsible for the administration of questionnaires and storing and processing of information, University administration was trusted for correctness and legality. We can conclude that all pragmatic facets of information, except performativity, were relevant in the design, introduction and functioning of the ETCU system.

Apart from the pragmatic facets of information, semantic facets were also relevant here: the facet of *comprehensibility* of requested information (questions for students); *contextuality* of information (for both students and staff) and *level of detail* (aspects of quality assessed by the questionnaire and details included in the reports for staff). In addition, practical consideration of student *access* to the ETCU system (a syntactic facet of *physical access*) and timely completion of questionnaires by students (an empirics facet of *speed*) remained relevant for the successful functioning of ETCU.

As described above the aim of ETCU system was to provide individual course and teacher quality information to teaching staff and only aggregated reports for departments/schools to University managers. The purpose was continuous course and teaching quality monitoring and self-improvement, based on regular and systematic feedback from students. However, in some universities the usage of information from ETCU changed when individual reports were also provided to superiors (heads of schools, deans). Instead of being used only by staff for self-improvement reports were also used by superiors as performance indicators of staff; this practice soon led to the use of ETCU reports for assessing staff performance for promotions. This change in the aim and purpose of ETCU and the use of information has had significant implications that can be understood by analyzing several pragmatic facets.

First, we can see the change in the target social practice facet of information-in-use. The initial assumptions about potential information (reports from ETCU) serving social practice of learning and teaching were not congruent with the usage of these reports for social practice of staff performance evaluation and promotion. Second, the change from feedback information from students for self-improvement to performance indicators used for assessing and promoting staff has had profound implications on staff attitude toward and use of ETCU. Teaching staff became more concerned with performance assessment scores as such rather than the quality of courses and delivery. This indicates the change of action relevance facet: some staff thus adapted their practice and behavior by focusing on improving their scores and became more concerned with improving students impressions than students learning. Third, the potential information (reports) converted into information-in-use made staff adapt their behavior to maximize the scores and thus change the practice according to the image implied in the assessment questions. The facet of performativity of information can explain how information-in-use can not only inform action but also perform reality. In other words, interpretation of reports and their conversion into information-in-use not only helped staff understand student assessment of quality and consequently take action to improve quality; the conversion to information-in-use in a different social practice (of staff performance assessment and promotion) made staff change practice to perform a particular reality (optimize scores).

Discussion

Over the last few decades IS scholars have repeated their calls for IS researchers to engage more seriously with information as a concept (e.g. Boland 1987; Lee 2010; Mingers 1996; Stamper 1973). However, to date not much progress on understanding 'information' has been made. We argue that the reason for this lack of progress is that one key characteristic of 'information' is that it is fuzzy, blurring for instance what we believe to be the case (ontological) and how we can know about what is the case (epistemology). This "blurriness" of information is not a defect but key for understanding what information is. However, so far approaches for conceptualizing information are grounded in a particular understanding of language where words, such as 'information' have a particular and well-defined meaning. Building on Wittgenstein's (1953) philosophy of language the paper develops an alternative descriptive theory of information where understanding of information is not limited to a particular and definite meaning.

Engaging with the concept by describing how information is used in the literature, we state two claims for conceptualizing information. The first claim states that three different uses of information are currently conflated by the term 'information'. Firstly, there is the content that is (to be) stored in ICT which can be more precisely labeled 'intended information'. Secondly, there is the output provided by ICT for a user which can be labeled 'potential information'. Finally, if the output is actually used and considered relevant and useful in practica, we can speak of 'information-in-use'. This distinction is important as it can help us clarify confusion and misunderstandings caused by the use of one word 'information' for all three concepts in both IS research and practice.

The second claim states that information can be described by different facets. Looking at the facets of information provides the foundation for a better understanding of information in a way that can help to ascertain the transition of intended information when a system is designed into information-in-use when a system is used in everyday practices. By going through each of the facets related to information, one can attempt to improve the match between the information use that is envisaged and the way intended information is stored and reproduced. Importantly these facets also reveal that information is simultaneously related to social, as well as cognitive, technological and material aspects. We therefore offer a conception of information that resonates with a socio-technical understanding of IS (Alter 2008; Checkland and Holwell 1998; Galliers 2003; Lee 2001, 2004, 2010; Paul 2010).

According to the descriptive theory of information, information can neither be seen as solemnly arising from objects conveying signs, nor as only depending on a subject gaining understanding. Information always requires both: social actors and materiality; subjects and objects. The descriptive theory of information can therefore be used to advance sociomaterial and socio-technical theorizing for IS (Cecez-Kecmaonovic et al. 2014). The descriptive theory of information relates the concept of information through different facets simultaneously to the social and the material. It therefore opens up a new avenue for advancing a sociomaterial approach to information and IS that can address the critique that the concept of sociomateriality lacks concreteness (Kautz and Jensen 2013).

One implication of our research is that it enables a better understanding of information in practice by distinguishing three forms of information that are currently conflated when talking about information. The concepts of intended information, potential information and information-in-use thus enable the drawing of a meaningful difference that has important implications for IS practitioners, as well as for IS education and training. Secondly, the paper provides an understanding of information that enables the dissection of the concept into 15 different facets. Not only does this allow IS researchers and practitioners to understand how information is simultaneously technological as well as social, it also enables them to appropriate facets of information that are of particular relevance in different contexts. The descriptive theory of information thus offers a device for communication that, for instance, can help practitioners from different domains to converge and negotiate a particular working conception of information for their purpose. By focusing on different facets of information a working group can thus develop a specific definition of information that will best suit and support them in their concrete endeavor.

Future Research

The proposed descriptive theory of information by its nature is a living theory that researchers and practitioners can use and develop further on the go. This paper is therefore to be seen as an invitation to researchers to extend the ways information has been and can be described in the literature or for IS research purposes. There are therefore various ways in which future research can contribute towards developing a descriptive theory of information further.

Further development of the descriptive theory of information may involve adding new dimensions for describing information beyond the two dimensions introduced in this paper. Another possible avenue may be to further investigate how different semiotic approaches to information systems could be related to a descriptive theory of information (Mingers and Willcocks 2014). Furthermore, a contribution may be made by, perhaps, enriching descriptions of information within the proposed dimensions and facets. For instance, we believe that there may be other facets of information that emerge from usage that we have not covered or that might come from future use of the concept of information.

And finally, we could only briefly engage with each facet of information. There is therefore the potential to investigate each facet more thoroughly. For instance, there is evidence that users prefer sources that are easily accessible to them or that are in close physical proximity to them (Chopra and Dexter 2008; Rice et al. 2001). Therefore, one question arising from this would be whether ease of physical access to sources may increase the trustworthiness in the (potential) information that they provide.

Conclusion

Over the last decades IT has progressed immensely, however, in IS understanding of 'information' has not advanced at a comparable rate. For forty years the path commonly taken to advance understanding of

information was to develop thorough definitions of what information is, for instance, by defining information in terms of knowledge (Boland 1987; Kettinger and Li 2010; Tuomi 1999), data (Ackoff 1989; Churchman and Holwell 2006) or meaning (Mingers 1995, 2010). However, these definitions are building on different sets of assumptions and are therefore at least partially contradicting if not incommensurate with each other. Furthermore, while these approaches for conceptual engagement with information have lead to some progress, the progress has not been sufficient. There is therefore a clear need for IS to further its efforts to conceptually understand information (Browne et al. 2015; Lee 2010; McKinney and Yoos 2010).

Instead of seeking a more refined definition of what information is, the descriptive theory of information proposed here embarks on a fundamentally different path for understanding information. Building on Wittgenstein's philosophy of language we describe how information is used and what it is used for, thus breaking with the representational understanding of language underlying earlier approaches for advancing conceptual understanding of information for IS. While definitions are often used in academic work they are only secondary to what we seek to achieve:

"I do say it is for most problems quite irrelevant whether a term can be defined or cannot be defined, or how it is defined. All that is necessary is that we make ourselves understood," (Popper 1994, p. 18).

The descriptive theory of information enables IS researchers, practitioners and educators to make themselves better understood by clarifying what they mean by information. Both dimensions for describing information developed in this paper can help clarify what is meant by information and how information may be related to different facets in a particular situation (claim 1 and 2). Nevertheless the descriptive theory of information does not restrict researchers, practitioners and educators by ascribing one definite meaning to information.

While the descriptive theory of information introduced here is based on a particular philosophy and research approach it also offers potential for future research. In order to embark on a description of information we looked at the extant literature engaging with information within and beyond IS. While this offered a starting point for the development of a descriptive theory of information, future research needs to go beyond and empirically explore different facets and their use in practice more thoroughly. Such studies need to be appropriately designed so as to reveal how each facet arises and is dealt with in practice, and also how different facets of information may be interrelated, potentially influencing each other.

As a closing remark, the approach developed in this paper may raise the objection that only a conception of information that clearly defines what information is, is a valid one. To this objection we would like to respond by referring to Wittgenstein for a final time: "Is it even always an advantage to replace an indistinct picture by a sharp one? Isn't the indistinct one often exactly what we need?" (Wittgenstein, 1953, §71).

References

Ackoff, R. L. 1989. "From Data to Wisdom," *Journal of Applied Systems Analysis* (16:1), pp. 3–9.

Alter, S. 2008. "Defining Information Systems as Work Systems: Implications for the IS Field," European *Journal of Information Systems* (17:5), pp. 448–469.

Artandi, S. 1973. "Information Concepts and Their Utility," *Journal of the American Society for Information Science* (24:4), pp. 242–245.

Aspray, W. 1985. "The Scientific Conceptualization of Information: A Survey," *Annals of the History of Computing* (7:2), pp. 117–140.

Austin, J. L. 1962. *How to do things with words*. Oxford: Oxford University Press.

Bates, M. J. 2010. "Information," in *Encyclopedia of Library and Information Sciences*, M.J. Bates and M.N. Maack (eds.), New York: CRC Press, pp. 2347–2360.

Bellinger, G., Castro, D., and Mills, A. 2004. "*Data, Information, Knowledge, and Wisdom.*" [online] http://www.systems-thinking.org/dikw/dikw.htm

Beynon-Davies, P. 2009. "Neolithic Informatics: The Nature of Information," *International Journal of Information Management* (29:1), pp. 3–14.

Beynon-Davies, P. 2010. "The Enactment of Significance: A Unified Conception of Information, Systems and Technology," *European Journal of Information Systems* (19:4), pp. 389–408.

Blair, D. 2006. Wittgenstein, Language and Information. Back to the Rough Ground!, Dordrecht: Springer.

Boell, S. K., and Cecez-Kecmanovic, D. 2014. "A Hermeneutic Approach for Conducting Literature Reviews and Literature Searches," *Communications of the Association for Information Systems* (34), pp. 257–286.

Boland, R. 1987. "The In-formation of Information Systems," in *Critical Issues in Information Systems Research*, R.J. Boland and R.A. Hirschheim (eds.), New York, NY, USA: Wiley, pp. 363–379.

Brier, S. 2004. "Cybersemiotics and the Problems of the Information-Processing Paradigm as a Candidate for a Unified Science of Information Behind Library Information Science," *Library Trends* (52:3), pp. 629–657.

Brier, S. 2008. *Cybersemiotics: Why Information is not Enough!*, Toronto: University of Toronto Press.

Browne, G. J., Cheung, C. M. K., and Riedl, R. 2015. "Exploring the Information Frontier," in *ICIS 2015 Conference Theme* [online] http://icis2015.aisnet.org/en/paper-submissions/tracks/18-tracks/36-track-explore-info-frontier

Brown, J. S., and Duguid, P. 2000. *The Social Life of Information*, Boston: Harvard Business School Press.

Buckland, M. K. 1991. *Information and Information Systems*, Westport: Greenwood Press.

Capurro, R., and Hjorland, B. 2003. "The Concept of Information," *Annual Review of Information Science and Technology* (37), pp. 343–411.

Cecez-Kecmanovic, D., Galliers, R. D., Henfridsson, O., Newell, S., and Vidgen, R. 2014. "The Sociomateriality of Information Systems: Current Status, Future Directions," *MIS Quarterly* (38:3), pp. 809–830.

Checkland, P., and Holwell, S. 2006. "Data, Capta, Information and Knowledge," in *Introducing Information Management: The Business Approach*, M. Hinton (ed.), Hoboken: Taylor and Francis.

Checkland, P., and Holwell, S. 1998. *Information, Systems and Information Systems: Making Sense of the Field*, Chichester: Wiley.

Chopra, S., and Dexter, S. D. 2008. Decoding Liberation: The Promise of Free and Open Source Software, New York: Routledge.

Churchman, C. W. 1968. *The Systems Approach*, New York, NY: Delta Book.

Cole, F. T. H. 2008. "Taking 'Data' (as a Topic): The Working Policies of Indifference, Purification and Differentiation," in *19th Australasian Conference on Information Systems*, Christchurch.

Collins, A. 2007. "From H = log sn to Conceptual Framework: A short History of Information," *History of Psychology* (10:1), pp. 44–72.

Davenport, T. H. 1997. Information Ecology: Mastering the Information and Knowledge Environment, New York: Oxford University Press.

Diaz Nafría, J. M., Pérez-Montoro, M., and Salto Alemany, F. 2010. *Glossary of Concepts, Metaphors, Theories and Problems Concerning Information*, J.M. Diaz Nafría, M. Perez-Montoro Gutierrez and F. Salto Alemany (eds.), León: Universidad de León, Bitrum.

Drummond, H. 2011. "MIS and Illusions of Control: An Analysis of the Risks of Risk Management," *Journal of Information Technology* (26:4), pp. 259–267.

Ezzy, D. 2002. *Qualitative Analysis: Practice and Innovation*, Crows Nest, Australia: Allen and Unwin.

Faÿ, E., Introna, L., and Puyou, F. 2010. "Living With Numbers: Accounting for Subjectivity in/with Management Accounting Systems," *Information and Organization* (20:1), pp. 21–43.

Fischer, R. 1993. "From Transmission of Signals to Self-creation of Meaning: Transformations in the Concept of Information," *Cybernetica* (36:3), pp. 229–243.

Floridi, L. 2005. "Is Semantic Information Meaningful Data?," *Philosophy and Phenomenological Research* (70:2), pp. 351–370.

Floridi, L. 2009. "Semantic Conceptions of Information," in Stanford *Encyclopedia of Philosophy*, E.N. Zalta (ed.), Stanford: The Metaphysics Research Lab.

Fricke, M. 2009. "The Knowledge Pyramid: A Critique of the DIKW Hierarchy," *Journal of Information Science* (35:2), pp. 131–142.

Frohmann, B. 2004. "Documentation Redux: Prolegomenon to (Another) Philosophy of Information," *Library Trends* (52:3), pp. 387–407.

Fugmann, R. 2007. "Informationstheorie: Der Jahrhundertbluff. Eine Zeitkritische Betrachtung (Teil 1)," *Information Wissenschaft und Praxis* (58:8), pp. 449–458.

Galliers, R. D. 2003. "Change as Crisis or Growth? Toward a Trans-disciplinary View of Information Systems as a Field of Study: A Response to Benbasat and Zmud's Call for Returning to the IT Artifact," *Journal of the Association for Information Systems* (4:6), pp. 337–351.

Galliers, R. D. 1987. *Information Analysis: Selected Readings*, R.D. Galliers (ed.), Sydney: Addison-Wesley.

Gioia, D. A., Corley, K. G., and Hamilton, A. L. 2013. "Seeking Qualitative Rigor in Inductive Research: Notes on Gioia Methodology," *Organizational Research Methods* (16:1), pp. 15–31.

Goguen, J. A. 1997. "Toward a Social, Ethical Theory of Information," in *Social science, techical systems, an cooperative work. Beyond the great divide*, Londen: Lawrence Erlbaum Associates, pp. 27–56.

Hart, C. 1998. Doing a Literature Review. Releasing the Social Science Research Imagination, Thousand Oaks: SAGE Publications.

Hirschheim, R., and Klein, H. K. 2012. "A Glorious and Not-So-Short History of the Information Systems Field," *Journal of the Association for Information Systems* (13:4), pp. 188–235.

Introna, L. D. 1997. Management, Information and Power: A Narrative of the Involved Manager, Houndmills, Basingstoke, Hampshire: Macmillan.

Kallinikos, J. 2006. "Information out of Information: On the Self-Referential Dynamics of Information Growth*," Information Technology & People* (19:1), p. 98(115).

Kautz, K., and Jensen, T. B. 2013. "Sociomateriality at the Royal Court of IS A Jester' s Monologue," *Information and Organization* (23:1), pp. 15–27.

Kettinger, W. J., and Li, Y. 2010. "The Infological Equation Extended: Towards Conceptual Clarity in the Relationship Between Data, Information and Knowledge," *European Journal of Information Systems* (19:4), pp. 409–421.

Kuhlen, R. 1991. "Information and Pragmatic Value Adding: Language Games and Information Science," *Computers and the Humanities* (25:2), pp. 93–101.

Langefors, B. 1980. "Infological Models and Information User Views," *Information Systems* (5:1), pp. 17–32.

Lash, S. 2006. "Dialectic of information? A Response to Taylor," *Information Communication and Society* (9:5), pp. 572–581.

Lee, A. S. 2001. "Editor's Comments," *MIS Quarterly* (25:1), pp. iii–vii.

Lee, A. S. 2010. "Retrospect and Prospect: Information Systems Research in the Last and Next 25 Years," *Journal of Information Technology* (25:4), pp. 336–348.

Lee, A. S. 2004. "Thinking About Social Theory and Philosophy for Information Systems," *in Social Theory and Philosophy for Information Systems*, L.P. Willcocks and J.C. Mingers (eds.), Chichester: Wiley, pp. 1–26.

Lenski, W. 2010. "Information: A Conceptual Investigation," *Information* (1:2), pp. 74–118.

Lewis, P. J. 1991. "The Decision Making Basis for Information Systems: The Contribution of Vickers' Concept of Appreciation to a Soft Systems Perspective," *European Journal of Information Systems* (1:1), pp. 33–43.

Lin, S. 2010. "Information – A New Open Access Scientific Journal on Information Science, Information Technology, Data, Knowledge and Communication," *Information* (1:1), pp. 1–2.

Machlup, F. 1983. "Semantic Quirks in Studies of Information," in *The Study of Information: Interdisciplinary Messages*, New York: Wiley, pp. 641–671.

Martignon, L. 2001. "Information Theory," in *International Encyclopedia of the Social & Behavioral Sciences*, Elsevier, pp. 7476–7480.

Mason, R. M. 1979. *A Study of the Perceived Benefits of Information Analysis Center Services*. (Final Report National Science Foundation Contact No. DSI-7718035), Atlanta.

Mason, R. O., and Mitroff, I. I. 1973. "A Program for Research on Management Information Systems," *Management Science* (19:5), pp. 475–487.

Mckinney, E., Yoos, C., and Kroenke, D. 2012. "A Preliminary Information Theory of Difference," in *AMCIS 2012 Proceedings*, p. Paper 9.

McKinney Jr, E. H., and Yoos, C. J. 2010. "Information About Information: A Taxonomy of Views," *MIS Quarterly* (34:2), pp. 329–344.

McLeod, R., and Schell, G. 2007. *Management Information Systems*, Upper Saddle River: Prentice Hall.

Meadow, C. T., and Yuan, W. 1997. "Measuring the Impact of Information: Defining the Concepts," *Information Processing and Management* (33:6), pp. 697–714.

Mingers, J. 1996. "An Evaluation of Theories of Information With Regard to the Semantic and Pragmatic Aspects of Information Systems," *Systems Practice* (9:3), pp. 187–209.

Mingers, J. 1995. "Information and Meaning: Foundations for an Intersubjective Account," *Information Systems Journal* (5:4), pp. 285–306.

Mingers, J. 2010. "Prefiguring Floridi's Theory of Semantic Information," *Kent Business School Working Paper Series* (7595:235), pp. 1–18.

Mingers, J. 1997. "The Nature of Information and its Relationship to Meaning," in *Philosophical Aspects of Information System*s, R. Winder, S.K. Probers and I.A. Beeson (eds.), London: Taylor and Francis, pp. 73–84.

Mingers, J., and Willcocks, L. 2014. "An Integrative Semiotic Framework for Information Systems: The Social, Personal and Material Worlds," *Information and Organization* (24:1), pp. 48–70.

Morris, C. W. 1946. *Signs, Language and Behavior*, New York: Prentice-Hall.

Nauta, D. 1972. *The Meaning of Information*, The Hague: Mouton.

Neely, M. P., and Cook, J. S. 2011. "Fifteen Years of Data and Information Quality Literature: Developing a Research Agenda for Accounting," *Journal of Information Systems* (25:1), pp. 79–108.

Nunberg, G. 1996. "Farewell to the Information Age," in *The future of the book*, Berkeley: University of California Press, pp. 103–138.

Paul, R. J. 2010. "Loose Change," *European Journal of Information Systems* (19:4), pp. 379–381.

Peirce, C. S. 1955. *Philosophical Writings of Peirce*, J. Bachler (ed.), New York: Dover Publications.

Popper, K. R. 1994. Knowledge and the Body-Mind Problem: In *Defence of Interaction*, M.A. Notturno (ed.), London: Routledge.

Puyou, F., Quattrone, P., McLean, C. and Thrift, N. 2012. *Imagining Organizations. Performative Imagery in Business and Beyond*. New York, NY: Routledge.

Rice, R. E., McCreadie, M., and Chang, S.-J. L. 2001. *Accessing and Browsing Information and Communication*, Cambridge: MIT Press.

Ritchie, D. 1986. "Shannon and Weaver - Unreveling the Paradox of Information," *Communication Research* (13:2), pp. 278–298.

Rowley, J. 2007. "The Wisdom Hierarchy: Representations of the DIKW Hierarchy," *Journal of Information Science* (33:2), pp. 163–180.

Shannon, C. E. 1948. "A Mathematical Theory of Communication," *Bell System Technical Journal* (27:3,4), pp. 379–423; 623–656.

Shannon, C. E., and Weaver, W. 1949. *The Mathematical Theory of Communication*, Urbana: University of Illinois Press.

Stamper, R. K. 1973. Information in Business and Administrative Systems, London: Batsford.

Stamper, R. K. 1987. "Semantics," in *Critical Issues in Information Systems Research*, London: Wiley, pp. 43–78.

Stamper, R. K. 1991. "The Semiotic Framework for Information Systems Research," in *Information Systems research: Contemporary Approaches & Emergent Traditions*, H.-E. Nissen, H.K. Klein and R. Hirschheim (eds.), Amsterdam: North Holland, pp. 515–528.

Stamper, R. K. 1992. "Signs, Organizations, Norms and Information Systems," in *Proceedings Third Australian Conference on Information Systems*, Wollongong, Australia, 5-8 October, pp. 21–65.

Stamper, R. K. 1985. "Towards a Theory of Information. Information: Mystical Fluid or a Subject for Scientific Enquiry?," *Computer Journal* (28:3), pp. 195–199.

Steiner, C. 2012. *Automate This: How Algorithms Came to Rule Our World*, New York, NY, USA: Penguin Books.

Steinmüller, W. 1993. Informationstechnologie und Gesellschaft: Einführung in die Angewandte Informatik, Darmstadt: Wissenschaftliche Buchgesellschaft.

Suchman, L. A. 1987. Plans and Situated Actions: The Problem of Human-Machine Communication, Cambridge: Cambridge University Press.

Taylor, R. S. 1986. Value-Added Processes in Information Systems, Norwood: Ablex.

Tuomi, I. 1999. "Data Is More Than Knowledge: Implications of the Reversed Knowledge Hierarchy for Knowledge Management and Organizational Memory," *Journal of Management Information Systems* (16:3), pp. 103–117.

Webster, J., and Watson, R. T. 2002. "Analyzing the Past to Prepare for the Future: Writing a Literature Review," *MIS Quarterly* (26:2), pp. xiii–xxiii.

Weick, K. E. 1985. "Cosmos vs. Chaos: Sense and Nonsense in Electronic Contexts," *Organizational Dynamics* (14:2), pp. 51–64.

Weick, K. E. 1989. "Construction Theory Disciplined Imagination," *Academy of Management Review* (14:4), pp. 516–531.

Weick, K. E. 1995. "What Theory is Not, Theorizing Is," *Administrative Science Quarterly* (40:3), pp. 385–390.

Wittgenstein, L. 1958. *Blue and Brown Books*, New York: Harper.

Wittgenstein, L. 1953. *Philosophical Investigations*, New York: Macmillan.

Wright, A. 2007. *Glut: Mastering Information Through the Ages*, London: Cornell University Press.

Zhang, Y. 2011. "*The Secret Life of ERP: From Technical Tool, Instrument of Control, to Transformative Agent*", Unpublished PhD Thesis, University of New South Wales, Sydney, Australia.

Zuboff, S. 1988. In the Age of the Smart Machine: The Future of Work and Power, New York: Basic Books.