Is IT changing the world?

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IS IT CHANGING THE WORLD? CONCEPTIONS OF CAUSALITY FOR INFORMATION SYSTEMS THEORIZING[1]

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Whatever answer one gives to the question "Is information technology changing the world?," the answer contains reasoning about causality. Causal reasoning is central to IS theorizing. This paper focuses on the concept of causal structure, defined by Markus and Robey (1988) as a theorist's assumptions about causal influences in IS phenomena, and proposes a framework of causal structure, warranted by philosophy and social theory, specialized for the needs of Information Systems scholars. The three dimensions of the framework concern the theorist's views about the reality and meaning of causation (causal ontology), about that which is changed in causation (causal trajectory), and about the role of humans and/or technology in bringing about the change (causal autonomy). On each dimension, mutually exclusive alternative positions are described, backed by authoritative warrants, and illustrated with IS examples. The framework aims to offer useful insights into the nature of IS theory and the conundrum of theoretical contribution.

Keywords: Causality, theory building, social theory, philosophy of knowledge, philosophy of action

Introduction

Theory is a topic of great recurrent interest to IS audiences (Avison and Malaurent 2014; Grover et al. 2008; Rivard 2014; Straub 2012; Weber 2012). Writings on the topic explore whether or not a theoretical contribution is needed in published IS research (Agerfalk 2014), what constitutes a theoretical contribution sufficient to warrant publication in leading IS journals (Rivard 2014), whether a theoretical contribution in IS journals needs uniquely IS content (Straub 2012), and how to go about enhancing or building theory to make a distinctive theoretical contribution to the IS field (Avgerou 2013b; Grover et al. 2008; Truex et al. 2006). Despite the wealth of commentary, the nature of IS theory remains a conundrum for many.

One possible explanation for this state of affairs is the existence of profound, but unacknowledged, differences of opinion about what a good theory looks like, that is, about the acceptable structure of theoretical arguments. For example, opinions differ as to whether a good theory is expressed as a statement of association among variables, as a statement about a process or mechanism by which some outcome is believed to occur, or as a statement about an inseparable intertwining of entities and conditions in specific situations. Statements like these are basically statements about causation, and they are central to many (if not all) conceptions of theory (Gregor 2006), whether or not words like cause, causes, causal, causation, or causality are explicitly used.

Many discussions of causality deal with epistemology and methodology (Jackson 2016; Mingers 2014). Consider Gregor's (2006) classic paper on the nature of theory in information systems, in which she highlighted regularity (or nomological) analysis, counterfactual analysis, probabilistic causal

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analysis, and manipulation (or teleological) analysis as different approaches to the analysis of causation. To this list might be added narrative analysis, sequence analysis, configuration analysis, and critical analysis, among others. By contrast, this paper focuses on the *conceptualization* of causality—that is, on theorists' explicit or implicit assumptions about the nature, aspects, and meanings of the concept of causality as it relates to their research interests. In other words, this paper focuses on the *causal structure* of theory, which is viewed as an essential part of causal reasoning in the physical and social sciences (Hahn et al. 2017), not to mention our own field (Markus and Robey 1988).

Our inquiry has led us to the conclusion that differences in beliefs about causality create much confusion about theory in our field. This paper is premised on the notion that a deeper understanding of causality will contribute to a deeper understanding of theory and thereby alleviate some of the confusion surrounding theoretical contributions. Accordingly, we believe that the analysis of causal structure can help IS scholars better perform activities such as editorial evaluation and theory building.

The specific aim of this paper is to present a framework of causal reasoning for IS research. The framework is based on the literatures on philosophy, social theory, and information systems. It consists of a set of alternative positions (or stances or "wagers" (Jackson 2016)) on three core causal dimensions. The positions are offered as provisional analytic constructs, rather than faithful representations of an empirical reality, that aim to contribute by offering useful insights into the nature of IS theory and the conundrum of theoretical contribution.

Our first task is to justify our focus on causality and the dimensions of our framework. Next, we discuss positions on each dimension. Following that, we show how the positions combine in IS theories and discuss how the framework may be useful.

Background

This section explores two questions. First, why is causality important enough to deserve the attention of IS scholars and to serve as a basis for understanding theory? Second, what core aspects of the concept of causality deserve particular attention by IS theorists?

Why Is Causality Important?

Causality has not much been discussed in the IS literature. Some significant exceptions include Avgerou (2013b), Mingers (2014), Mingers et al. (2013), and Smith (2006) on interpretivism and critical realism, Burton-Jones et al. (2015) and Markus and Robey (1988) on variance versus process and systems theories, and Gregor (2006), Gregor and Hovorka (2011), and Hovorka et al. (2008) on theoretical goals and methods. The relative paucity of IS literature on causality may reflect the belief that the major philosophical issues associated with causality have long been settled. To the contrary, causality continues to attract active attention for its centrality to the core concerns of scholars in philosophy, natural science, social science, and even some of the humanities, including history and law. For example, Beebee et al. (2009), Kincaid (2012), and Waldeman (2017) have recently published compendia of writings on causality.

Perusal of these and other writings on causality suggests the following conclusions. First, the concept of causality features prominently in works on theory and method in many fields, regardless of philosophical perspective. A far from definitive list of influential treatments of causality would include the following: Bunge (1996), Juarrero (2011), Lincoln and Guba (1985), Pearl (2009), Salmon (1998), and Woodward (2003).

Second, there is no consensus in these writings about what causality is. Table 1 provides a sampling of conceptions of causality and causation from a variety of sources that differ on many points, including

- whether causality exists in the real world or only in the mind of the observer (i.e., whether "causality" is a theory)
- whether causality involves variables, actors, events, actions, objects, properties, or some combination
- whether causality involves only physical causation, only ideas and mental events, or some combination of both
- whether causality can or cannot involve multiple causes, feedback loops, bidirectional effects, simultaneous bidirectional effects, nondeterministic relationships, etc.
- whether the concept of causality is only applicable to "populations" of entities such as events ("general causation"), whether it is only applicable to specific (past) situations ("singular causation"), or whether it is applicable (with some qualifications) to both[2]

[2]"There is no consensus [in philosophy] on this issue.… Nevertheless, and despite some suggestions to the contrary … it also seems implausible that these two causal notions are unrelated to each other" (Woodward 2003, pp. 74-75). See also Mahoney (2008).

Table 1. Contrasting Conceptions of Causality/Causation

Definition	Source
[For Hume] the presumption of a causal relationship does not itself arise from the experience of the object, but is somehow added onto the experience by the mind (p. 74). For neo-positivists, causation is equivalent to an empirical generalization …. (p. 220). [There is a] set of disputes about whether causation is a relation between events themselves, the properties of events, or the properties of events only under certain descriptions (p. 165, note 48).	Jackson (2016)
The topic of this lecture is causality—namely, our awareness of what causes what in the world and why it matters (p. 401). The distinction [between statistical and causal concepts] is crisp, necessary, and useful … [and] based on the distinction between statics and kinematics. … Causal analysis goes one step further; its aim is to infer the dynamics of events under *changing conditions*, for example, changes induced by treatments or external interventions, or by new policies or new experimental designs (p. 332). Definition 7.5.1. An event C is causally relevant to E if there is at least one condition F in some background context K such that P(E | C, F) > P(E | ¬ C, F) (where K is) a set of variables and F a particular truth-value assignment to those variables (p. 250). Since Holland coined the phrase "No Causation Without Manipulation" … many good ideas have been stifled or dismissed from causal analysis. … Surely we have causation without manipulation (p. 361).	Pearl (2009)
Cook and Campbell (1979) write: "*The paradigmatic assertion in causal relationships is that manipulation of a cause will result in the manipulation of an effect*. … Causation implies that by varying one factor I can make another vary" (p. 25). Thinking about causal relationships as relationships that are potentially exploitable for purposes of manipulation enables us to understand why causal claims have many of the features they do and help to adjudicate between rival claims about those features. … It explains why causal claims involving causes that are unmanipulable for conceptual reasons are typically unclear. … Finally, it illuminates the role of spatiotemporal contiguity in causation and the relationship between causal claims and the laws of nature (p. 151).	Woodward (2003)
Predictive relationships focus on the question "Is variability in A related to variability in B?" (p. 139). Scientists generally think of causality in terms of change. Variable X is said to be a cause of Y if changes made to the crucial properties of X produce changes in Y (p. 139). [The six types of causal relationships are] (1) direct causal, (2) indirect causal, (3), spurious, (4) moderated causal, (5) bidirectional causal [with time lags], and (6) unanalyzed (p. 141). There is no such thing as simultaneous reciprocal causality (p. 153).	Jaccard and Jacoby (2010)
I had hopes that the fundamental causal concepts could be explicated in terms of statistical concepts alone … . By 1980 that no longer seemed possible, and I shifted my focus … . The basic idea—stated roughly and briefly—is that an intersection of two processes is a causal interaction if both process are modified in the intersection in ways that persist beyond the point of intersection, even in the absence of further intersections. … However, not all intersections of causal processes are causal interactions. … It is important to recognize that these causal mechanisms are not necessarily deterministic (pp. 70-71).	Salmon (1998)
[T]he concept of causation adopted in case-oriented research is appropriate for the population level, whereas the conception of causation used in population-research is valuable for making predictions in the face of uncertainty (p. 412).	Mahoney (2008)
One says that event C is *the* cause of event E if, and only if, the occurrence of C is sufficient for that of E … we say that C is *a* cause of E if and only if C is necessary but not sufficient for E. … The causal relation links *events*—not things, properties, or states. That is, only changes can be causally related. … We distinguish two types of causal mechanism: type 1, involving *energy transfer*, as in manual work, and type 2, involving a *triggering signal*, as in giving an order to fire a gun or an employee (p. 31). Reasons must be distinguished from causes: the former are constructs, whereas the latter are real events … . [R]easons and causes join in both thought and action (p. 35).	Bunge (1996)
[E]ffects are brought about by bundles or configurations of mechanisms, some of which contribute to the effect and some of which may operate to counteract the effect or reduce its magnitude. [Such] explanations take the form of "Y occurred because of A, despite B" where A is a set of contributing causes and B is a (potentially empty) set of counteracting causes (p. 145).	George and Bennett (2005)
[A] replacement concept for causality, is that of *mutual simultaneous shaping*. Everything influences everything else, in the here and now. Many elements are implicated in any given action, and each element interacts with all of the others in ways that change them all while simultaneously resulting in something that we, as outside observers, label as outcomes or effects. But the interaction has no directionality, no need to produce that particular outcome (indeed, the outcome may be a totally unpredictable morphogenetic change); it simply "happened" as a product of the interaction—the mutual simultaneous shaping (pp. 151-152).	Lincoln and Guba (1985)
[Cause] is regularly meant in two senses … . We have, first physical cause and, second factual cause. … [T]hese two senses [must] be kept distinct, but we cannot dispense with either one. Factual cause is used primarily to assign responsibility, as in simple explanation, or in explanation with a moral cast—blame, praise, credit, fault, guilt, and so forth. The purpose of physical cause … is simply to describe the physical workings of the world, as in science, medicine, cause-of-death coding, engineering, and storytelling (p. 25).	Mohr (1996)
Constructivists privilege constitution in preference over causation. … It is incumbent upon constructivists to develop a non-positivistic understanding of causation and use it to spell out the ways in which constitution can have causal consequences (p. 1) Jackson makes the case for "adequate causality". It entails "the contingent coming-together of processes and patterns of social action in such a way as to generate outcomes" (p. 3).	Lebow (2009)

Many statements in Table 1 are incompatible with others. Even very general dictionary definitions of causality such as "the relationship between a cause and an effect" or "the belief that everything is caused" fail to encompass the range of meanings in the examples. The theorist's choice is either to accept one definition of causality and reject the others or to accept that the differing conceptualizations capture important, nonidentical, dimensions of the same basic concept.

Third, numerous writings on causality make the point that each field of study does, and *should*, interpret the concept of causality in a distinctive manner to address the field's unique subject matter or phenomenon of interest. Certainly, many scholars have debated the appropriate definition of causality in the social versus the natural sciences (Kaplan 1964; Von Wright 1971). In addition, scholars have proposed specific requirements for causal reasoning in fields such as biology (Waters 2007), international relations (Jackson 2016; Mohr 1996), sociology (Goldthorpe 1999), and law (Lagnado and Gersenberg 2017; McCann 1996).

In short, we argue that the concept of causality affords a useful way to think about theory, that causality has multiple dimensions, and that beliefs about causality may need to be specialized for the needs of IS theorists.

What Are the Core Aspects of Causality?

The starting point for our framework is the observation, mentioned above, that causality has disparate and sometimes irreconcilable definitions. This incommensurability poses a significant challenge for those who hope to develop and tailor a causal framework for the theoretical needs of IS scholars.

Our approach in this paper is to accept that it is not possible to reconcile or unify the divergent definitions of causality, while at the same time proposing that one does not have to choose among them. In other words, embracing the diversity of views for what each has to offer in light of particular research questions or phenomena is a viable option for IS scholars.

We found one treatment of causality particularly helpful to us in justifying the need for a pluralistic framework of causality and in supplying a rationale for the dimensions of our framework. This is the theory of embodied realism (Lakoff and Johnson 1999), which derives from research in philosophy, neuroscience, and linguistics. In brief, the theory holds that humans have evolved the ability to reason abstractly about the world through analogy to their bodily experiences. The concept of "causation is absolutely central to any plans [humans] make for acting in the world" (Lakoff and Johnson 1999, p. 170). Not surprisingly, humans have developed many words and patterns of thought about causation that are related to bodily positions and activities such as moving, sitting, grasping, throwing, etc. Some examples include

> FDR *brought* the country out of the depression. The home run *threw* the crowd into a frenzy. That experience *pushed* him over the edge. The stock market crash *propelled* the country into a depression. (Lakoff and Johnson 1999 p. 187].

In sum, reasoning about causation is "hardwired" (Lincoln and Guba 1985) in the human bodily experience, and people reason about causation in terms of body movement metaphors.

The Causal Ontology Dimension

Labeling human conceptions of causality as metaphors immediately raises a question that has been, and continues to be, the subject of much philosophical and social scientific writing: Does the metaphorical nature of human reasoning about causation mean that causation does not exist in the world? Lakoff and Johnson's answer to this question is reassuring to those who are willing to embrace a pluralist view. Lakoff and Johnson asserted that conceptualizing causality as a human metaphor does *not* necessarily imply that causality has no real existence, "and it [also] does not require either idealism or total relativism" (Lakoff and Johnson 1999, p. 233). In other words, recognizing the metaphorical nature of human reasoning about causality is compatible with both realist and non-realist (e.g., neopositivist and interpretivist) philosophical perspectives.

While supporting pluralism, Lakoff and Johnson's conceptualization of causality makes it clear that a theorist's views about causation as a real phenomenon is a fundamental, if not *the* fundamental, theoretical choice in academic inquiry. Hence, we call the first dimension of our framework **causal ontology** to denote a theorist's beliefs about the reality of causality. Adopting a position on the causal ontology dimension is a critical theoretical choice for scientists, whether natural or social, as well as for many humanists, including lawyers and historians.

The Causal Trajectory and Causal Autonomy Dimensions

The second and third dimensions of our framework derive from two primary human metaphors about causation. According to Lakoff and Johnson, the concept of causality is a

linguistic category of great complexity. They described it as a radial category: a set of ideas that radiate outward from the human body at the center. Although there are many rays, two primary metaphors represent the idea of causation in figure-ground (foreground-background) relationship. The first is the metaphor of the container or **location**, involving the forced movement of an entity from one place to a new location. The second is the metaphor of **object**, involving the transfer of a possessible object to or from an entity.

Lakoff and Johnson gave this example of the location metaphor: "The home run sent the crowd into a frenzy." In this sentence, the affected entity (the crowd) is in the foreground and the object or effect (a frenzy) is in the background. The affected entity is said to move to a new location (a frenzy), as a result of the home run (the cause). Of the object metaphor, Lakoff and Johnson gave this example: "The loud music gave a headache to each of the guests." In this sentence, the object (headache) is in the foreground and the affected entity (the guests) is in the background. The object is said to move to the affected entity (the guests) as a result of the loud music (cause) (Lakoff and Johnson 1999, p. 199).

Lakoff and Johnson argued that the figure-ground perceptual shift reflected in the location and object causality metaphors is a fundamental aspect of human cognition. Each of the metaphors is useful, because it expresses a different idea about movement or change against a background. Neither metaphor can be subsumed under the other or replaced by a single overarching idea. Humans need both of these incommensurable metaphors for reasoning about causality.

These two primary causal metaphors form the second and third dimensions of our framework of causal structure. We call our second dimension **causal trajectory**, because the word trajectory connotes an *entity moving in space and time*. This dimension foregrounds the entity that the theorist believes to be moving (that is, changing or being affected) and shifts the effect of the movement into the background. The affected entity could be an individual, a group, a socio-technical system or infrastructure, an organization, an organizational field, a community, or an actor network. We define the causal trajectory dimension as the theorist's views about the causal movements of the affected entity. Adopting a position on the causal trajectory dimension represents a fundamental theoretical choice for scholars who study humans and social entities.

The third dimension of our framework foregrounds the theorist's beliefs about the *movement of an effect*. Here the effect refers to causal influences, which are sometimes referred to under the label of agency (human and/or material). We call this third dimension **causal autonomy**, because the word autonomy means self-governing or freedom from external influences, both of which meanings have been applied, not only to humans, but also to technology. We define causal autonomy as the theorist's views about the movement of causal effects between human (or social) actors and technology. Adopting a position on the causal autonomy dimension is a theoretic choice of special importance for Information Systems scholars.

Observations about the Causal Structure Framework

Issues related to the causal ontology, causal trajectory, and causal autonomy dimensions have been extensively discussed in the philosophical and social theoretic literatures under various names, such as agency, structure, holism, individualism, materialism, and idealism. We chose our own names for our dimensions to avoid confusion or conflation (Barley 1998), because many similar concepts are discussed in the literature under different labels (e.g., materialism and determinism), and because some terms are used with different meanings or referents (e.g., human agency in relationship to social structure versus in relationship to material objects).

Table 2 presents the definitions of the three dimensions and, for each, a set of basic positions. In the next three sections of the paper, we flesh out the dimensions and positions of our framework. We discuss the philosophical and social theoretic warrants for each dimension, and we elaborate on the basic positions, providing their warrants and one or more IS-relevant examples. We conclude each section with additional observations about the dimension and positions.

Dimension I. Causal Ontology

Causal ontology concerns a theorist's views about the reality of causality. The causal ontology dimension has roots in several long-standing debates in the philosophy and social science literatures (De Pierris and Friedman 2013; Falcon 2012; Juarrero 2011; Salmon 1998; Woodward 2003). Within these debates, three basic positions can be discerned. The first is that causality is a metaphor. Causation is a concept that refers to something that is unobservable, hence metaphysical and nonscientific. This position originates from David Hume (1711–1776). Different rationales for this position have been offered by Kant (1724–1804) and Meillassoux (2010).

The second basic position is that causation refers to something happening in the real world, that is, a process that connects inputs to outputs, such as a transfer of matter, energy, or

Table 2. Three Critical Dimensions of Theoretical Causal Structure

Dimension	Definition	Basic Positions
Causal Ontology	A theorist's views about the reality of causality	• Causality is a convenient **metaphor** for a logical or metaphysical association • Causality implies a real **mechanism**, that is, a process that connects inputs to outputs • Causality is a **misnomer**, because it incorrectly implies unidirectional, deterministic, external forces
Causal Trajectory	A theorist's views about the causal movements of an affected entity in space and time	• Causality occurs across the boundaries of a **stratified** entity • Causality occurs within (**internal** to) an undifferentiated entity • Causality occurs through the **accretion (**growth and complexification) over time of a heterogeneous entity
Causal Autonomy	A theorist's views about movement of causal effects between human (or social) actors and technology	• Causal effects move from people (or social actors) to technology—technology as **instrument** • Causal effects move from technology to people (or social actors)—technology as **influencer** • Causal effects move back and forth between people (or social actors) and technology—technology as **interactant**

information or a human or social dynamic, such as the self-fulfilling prophecy. This position is most commonly discussed under the headings of scientific (Bunge 1996), speculative (Harman 2010), or critical (Archer et al. 1998) realism.

The third basic position is that causation is a misnomer, because it incorrectly implies unidirectional, deterministic, and/or external influences and thereby radically oversimplifies and distorts what matters most in understanding human affairs. Because humans reflect on their own experiences, theorizing about people and social phenomena must necessarily differ from theorizing about physical and biological phenomena. This basic position has its origins in the philosophy of Dilthey (1833–1911) and exemplifies theorizing in numerous interpretive traditions. Some leading proponents of this position believe that a concept *like* causality is needed, both theoretically and in order to make practical recommendations, but that the concept needs complete redefinition (Lincoln and Guba 1985).

Below, we elaborate on the basic positions presented above to bring them closer to the kinds of causal arguments one finds in the IS and related literatures. We call the elaborated positions directional association, causal mechanism, and constitutive causality.

Position I.A. Directional Association

The position statement for directional association can be phrased as follows: Causality refers to regular associations among certain hypothetical or observed conditions, possibly including temporal precedence (hence the qualifier "directional"). Directional association theorizing is concerned with general causation only (i.e., causation in populations of similar entities or events) and does not apply to specific instances (i.e., individual cases).

Philosophical or Social Theoretic Foundations

The warrants for the directional association position derive from the philosophical writings of Hume and Kant. Both scholars believed that causality cannot be directly observed. Hume argued that it is only habit or custom that allows humans to infer causality from observations about regular associations among events. Among other contributions, Hume is remembered for the "three principles" formula by which an attribution of a causal relationship is to be considered logically sound: (1) contiguity in place and time of events, (2) temporal precedence of the cause relative to the effect, and (3) constant (regular) conjunction (association) between hypothesized cause(s) and effect(s).[3] Kant agreed with Hume that causality could not be observed from sensory perception, but he believed that causality was a pure concept (like time and space) that is common to all humans and allows

[3]In his famous example of the motion of the billiard ball hitting another and putting it in motion after the shock, Hume explained: "Let us try any other balls of the same kind in a like situation, and we shall always find that the impulse of the one produces motion in the other. Here, therefore, is a *third* circumstance, viz. that of *constant conjunction* betwixt the cause and the effect....Beyond these three circumstances of contiguity, priority and constant conjunction, I can discover nothing in this cause" (Hume 1740, *An Abstract of a Treatise on Human Nature*, cited in Salmon 1998, p. 193). Because the connection between cause and effect remains hidden, "causality" can be considered a metaphysical concept.

us to experience causal relationships in the sequences of events we observe in empirical reality (De Pierris and Friedman 2013).

The directional association position is very much alive today in the statistical relevance (SR) model of scientific explanation (Durand and Vaara 2009; Hovorka et al. 2008).

An Example from IS Research Literature

Agarwal et al. (2009) questioned the marked geographic variation in household internet usage in the United States. They reasoned on the basis of social influence theories that people whose peers used the Internet would use it also. Put differently, they hypothesized that peers exert a causal influence on individuals' technology use decisions. This paper differentiated between concepts that *describe* some aspect of the phenomenon or its context (such as number of children in a household, which is statistically correlated with Internet use) and concepts that can be plausibly claimed to be *causal* (e.g., peer influences). However, the paper did not address *how* the causal effect might have come about.

Position I.B. Causal Mechanism

The position statement for causal mechanism can be phrased as follows: Causality involves real physical, psychological, and/or social processes that connect inputs and outputs under certain conditions. Causal mechanism theorizing applies to both general (population) and singular (case) causation.

Philosophical or Social Theoretic Foundations

The causal mechanism concept evolved somewhat independently in two intellectual communities, scientific realism and sociology, that appear to be converging under the banner of critical realism (Hedström and Ylikoski 2010). Whereas adherents of the directional association position effectively give up on trying to specify what Hume called the "secret [hidden] connection" between causes and effects, scientific realists embrace the task of explaining why things happen (Bunge 1996; Machamer et al. 2000; Salmon 1998). The name they give to the hidden connection is *mechanism*, referring to a *physical* causal process that is hypothesized to "[transmit] energy, as well as information and causal influence" (Salmon 1998, p. 146). Mechanisms are conceptualized as (1) ontologically real, even if they are unobservable, (2) reasonably inferable as causal (through abduction), and (3) able to produce effects that would not happen otherwise.

Sociologists frustrated with the directional association position evolved the concept of a *social* mechanism (Avgerou 2013b; Hedström and Swedberg 1998a) to theorize, rather than merely to associate or describe, the connections between social context, human belief-formation, social interaction, and social outcomes. Not to be confused with a purely descriptive chain of unique events that lead from one situation to another (Hedström and Swedberg 1998b), social mechanisms are more or less *general* sets of social events or processes that, under certain circumstances, bring about changes in human social relations without necessarily being reducible to the actions of individuals (Gross 2009). Familiar examples of social mechanisms include the self-fulfilling prophecy ("an initially false definition of a situation [that] evokes behavior that eventually makes the false conception come true" (Hedström and Swedberg 1998b, p. 18) and Van de Ven and Poole's (1995) four "motors of change."

Early writings represented social mechanisms as abstract models, bits of theory, and analytic constructions or interpretations (Hedström and Swedberg 1998a). This understanding of causality is metaphorical, as is the directional association position. More recently, however, proponents of social mechanisms appear to have embraced the philosophy of critical realism (Archer et al. 1998; Bhaskar 1998; Bunge 1996; Sayer 2000; Sorensen 1998; Stinchcombe 2002) as a foundation for their theorizing (Hedström and Ylikoski 2010).

In critical realist philosophy, social mechanisms, like physical mechanisms, are seen as seen as enduringly at play in the real realm independently of our perception or awareness of them (Bhaskar 1975). Mechanisms generate actual events, only some of which can be perceived in the empirical realm. Mechanisms do not always produce actual events, because they may counteract each other or otherwise depend on the presence of various conditions (Mingers 2004).

The causal mechanism concept is often employed in general causal theorizing (e.g., about the population of evolving infrastructures (Henfridsson and Bygstad 2013) or of routines Goh et al. (2011)). However, the causal mechanism concept is also applicable to the study of individual cases and unique events (Avgerou 2013a, 2013b).

An Example from IS Research Literature

Volkoff et al. (2007) inquired into why enterprise systems, which are expected to make organizations more flexible, in fact make them more rigid. They inferred that embedding (of enterprise software into the organization) is the mechanism through which routines, roles, and data become rigid (Volkoff et al. 2007) with effects such as misfits (Strong and Volkoff

2010). However, they argued that rigidification effects depend on conditions that do not always occur. In a follow up study based on the same data, Volkoff and Strong (2013) concluded that the affordances of enterprise systems are also mechanisms that are actualized under certain conditions.

Position I.C. Constitutive Causality

The position statement for the constitutive causality position can be articulated as follows: "Causality" is a human belief about how meanings are enacted in highly situated social interactions (e.g., practices) and how people dynamically construct such interactions. Proponents of this position hold that beliefs about causality have real consequences. Constitutive causality theorizing applies to singular (case-specific) causation only.

Philosophical or Social Theoretic Foundations

We borrowed the label for this position from Schwartz-Shea and Yanow (2013), who used the term *constitutive causality* to describe how actors use language rules and interaction to make sense of a situation or phenomenon as they enact and transform it. This position has its origin in Dilthey's (1833–1911) philosophy. In opposition to Comte's (1798–1857) unified view of the sciences from physics to sociology, Dilthey argued against an overarching "universal explanatory typology for all historical facts" (Dilthey 1989, p. 141). Instead, Dilthey's philosophy celebrated the uniqueness of experience in human life arising from complex interactions and interpretations. Dilthey's philosophy led the way for interpretivism, including the phenomenology of Husserl, Heidegger, and Merleau-Ponty, as discussed in Introna and Ilharco (2004), and the hermeneutics of Gadamer and Ricoeur, as discussed in Myers (2004).

A key warrant for the constitutive causality position is the late Wittgenstein (1899–1951), who argued that beliefs and reasons are deeply implicated in subsequent human actions (Sandis and Tejedor 2017). Humans fundamentally create, share, and contest situations based on their interpretations of the meanings of those situations and on how firmly they hold to those interpretations (Wittgenstein 1958). Causality becomes real through language games in various situations. The constitution of cause-effect language games results from expressing our immediate reactions to what has affected us (Wittgenstein 1976). The game starts with a reaction to some phenomenon and complicates itself through language. Cause-effect is the belief in our minds when we imagine the important possibility that some event undoubtedly has a particular cause (Wittgenstein 1976). Thus, theorizing, according to Wittgenstein, is not about how or why things happen but rather about how situations and human meanings co-constitute each other. Furthermore, his stance that practices enacted through language games matter means that theorizing mainly involves *past* situations and relies on the identification and description of practices.

Examples from IS Research Literature

Ngwenyama and Lee (1997) investigated how and why email can support communicative action by enabling actors to move beyond their possible understanding of a situation as derived from the face validity of messages. The authors theorized that, with technologies such as email, human beings create or enact the meanings they come to hold and probe the validity claims advanced by others in order to emancipate themselves from distorted communications. Social actors can interpret messages as distorted by testing the claims made by others, thanks to the content feedback they receive in interaction. What happens makes sense to social actors when they can refer to their life-worlds to pre-interpret patterns of actions. In another illustration of this position, Fayard and DeSanctis (2010) showed how, through their engagement in a language game, members of online communities produced five discursive practices that defined and enacted their sense of we-ness.

Interrogating how to interpret passing or failing a Turnitin (plagiarism detection software) test, Introna and Hayes (2011) theorized that human and technological actors iteratively co-constitute their attributes (e.g., fairness) and roles (e.g., copy detection or plagiarism detection) in unexpected and uncertain ways due to interpretive frames that they hold of each other. Put differently, interactions between human and technological actors had the performative outcome of subverting intentionalities. Greek students typically learn to prepare for exams by memorizing large blocks of text. When they study in U.K. universities, where plagiarism detection software is used, duplicated text in Greek students' exam is often interpreted as plagiarism rather than preparation.

Additional Observations about Causal Ontology Positions

The discussion above can be summarized as follows. Strikingly different, even incommensurable, positions on the causal ontology dimension can be articulated. Each position has authoritative warrants in the philosophical or social theory literatures. Each position can be identified in some published research in IS and other fields. What may not be immediately clear is that each position produces a different *form* of theoretical statement. To illustrate that point, we took two IS research

Table 3. Positions on Dimension I Causal Ontology

Causal ontology refers to a theorist's views about the reality of causality. The illustrations below were crafted by the authors to parallel the position taken by Introna and Hayes (2011) and Hayes and Introna (2005)

Basic Position	Elaborated Position Statement	Illustrations from the IS Field
Metaphor Causality is a convenient metaphor for a logical or metaphysical association	**I.A. Directional Association** Causality refers to regular associations among certain hypothetical or observed conditions, possibly including temporal precedence (hence the qualifier "directional").	• The greater the use of plagiarism detection software by professors, the greater the number of students referred to disciplinary hearings for suspected plagiarism. • Use of several plagiarism detection packages results in fewer false positives and negatives than use of only one package.
Mechanism Causality implies a real mechanism, that is, a process that connects inputs to outputs	**I.B. Causal Mechanism** Causality involves real physical, psychological, and/or social processes that connect inputs and outputs under certain conditions.	• Plagiarism detection software redefines plagiarism (a complex phenomenon with many manifestations) and equates it with text duplication. Professors' use of the software can change the way professors understand plagiarism through the process of commensuration. • Professors' use of plagiarism detection software can improve the educational process by providing them with opportunities (not always taken) for discussions with students about the writing process and the meaning of original work.
Misnomer Causality is a misnomer, because it incorrectly implies unidirectional, deterministic, external forces	**I.C. Constitutive Causality** "Causality" is a human belief about how meanings are enacted in highly situated social interactions (e.g., practices) and about how people dynamically construct such interactions.	• Misinterpretations by both teachers and students emerged through the use of plagiarism detection software with Greek students in a U.K. educational system (Introna and Hayes 2011). • Use of plagiarism detection software with Chinese students who have learned by "patch writing" resulted in identity conflict and inappropriate student behavior (Hayes and Introna 2005).

exemplars of the constitutive causality position (Hayes and Introna 2005; Introna and Hayes 2011) and crafted theoretical statements about the same phenomenon, use of plagiarism detection software, consistent with the other two positions. As can be seen in the structured comparison in Table 3, the forms of these statements diverge considerably. But all of them are *causal* statements, and all are statements of *theory*.

Theoretical statements produced by scholars adopting the directional association position emphasize causal *effects*. Their chief concern is the regularity and strength (Ziliak and McCloskey 2014) of the association (described as "robust dependence" by Goldthorpe (1999)) among abstract theoretical properties of individuals, social entities or concepts, and technologies. This position often results in "stories about variables" rather than in "stories about actors" (individuals and collective actors such as organizations) (Ramiller and Pentland 2009). Directional Association theorists tend to "generalize" (unduly, according to Lee and Baskerville (2003)), across contexts.

Whereas directional association theories hypothesize about causal *effects*, the causal mechanism position focuses on the contingently general causal *processes* by which causal effects come about (Avgerou 2013b; George and Bennett 2005). For example, in the previously cited study by Agarwal et al. (2009), hypothetical mechanisms (not explored by the authors) by which peer influence could affect household internet use include (1) individual observation and imitation of others' internet use, (2) direct social pressure by peers on individuals ("if you want to contact me, use Skype"), or (3) shared cultural influences via mass and social media. Causal mechanism theorizing produces a different kind of generalizability argument than that found in directional association theorizing because of the emphasis placed by causal mechanism theorizing on the conditions and processes by which hypothesized outcomes occur, when they do.

Theoretical statements produced by scholars holding the constituted causality position generally remain highly "situated," that is, they do not aim to abstract and generalize

beyond the specific context studied. The constitutive causality position holds that, through language and interpretations of social rules and conditions, people enact their own reality (act according to their beliefs) with important consequences. Scholars who adopt the constitutive causality position produce research accounts in which theoretical statements take the form of stories about actors (Ramiller and Pentland 2009), situations, meanings, and interactions.

How does the causality ontology dimension of our framework differ from earlier ways of characterizing causal theorizing? The causal ontology dimension steers clear of Markus and Robey's (1988) simple distinction between process and variance theory, because process theories can take two distinct forms (George and Bennett 2005; Van de Ven and Poole 2005): (1) unique sequences of empirical events (as in a historical explanation), and (2) contingently general abstract mechanisms, singly or in combination.

Dimension II. Causal Trajectory

The causal trajectory dimension refers to a theorist's assumptions about the affected entity, whether the entity is an individual, an infrastructure, an organization, or a nation, and about its causal movements of in space and time. Our causal trajectory dimension encompasses and translates several fundamental philosophical and social science debates about the existence of society as an entity independent of the people who make it up, about the possibility of social influences on people, and about the conceptualization of society (e.g., as a social construction or a natural system).

Three basic positions on causal trajectory can be differentiated. The first position views affected entities as stratified, that is, consisting of layered or nested systems with relatively clear (if permeable) boundaries between systems and their environments. Change is theorized as movements across boundaries. This view can be traced back to Aristotle, who believed that causes had to be external to their effects. Thus, he could only explain the self-movement of animals by positing the existence of an external soul that acted on the body. Modern philosophers like Descartes rejected the idea of bodies or substances animated by their souls (Gnassounou and Kistler 2007), but the idea that hypothesized causes were necessarily external (i.e., exogenous) forces persisted from the Newtonian era until the mid-twentieth century (Juarrero 2002).

The widespread belief in causes as external to effects promoted the development of theories (in sociology, economics, and anthropology) about society as a whole that is greater than the sum of its parts and about "social forces" (institutions such as marriage, religion, law) that act on individuals. This philosophy, often called *holism* (Hollis 1994), was attacked by critics for denying the existence of human free will and was branded as cultural or environmental "determinism." By contrast, other philosophers argued that what is called society is merely the resultant of (and reducible to) individual actions and interactions—a philosophy often called *individualism* (Hollis 1994). An example is the view of financial markets as the aggregate of individual investors' behavior.

The holism versus individualism debate, also known as the (social) structure versus agency debate, continues to vex social theorists today (Bunge 1999). Holists charge that individualists' theories are undersocialized; individualists counter that the people in holists' theories are "social dopes." Numerous attempts have been made to resolve the different views. Some attempts reflect a view of society as a social construction (e.g. Alexander's neofunctionalism (1985) and Giddens' structuration theory (1979)), while at the same time conceptualizing "micro" and "macro" levels with inter-level influences. Other integrations adopt the critical realist view of a stratified natural and social world (e.g., Bunge's systemism (1999) and Archer's morphogenetic approach (1995)).

Systems theory and complex adaptive systems theory also rely on the idea of realist stratification. The phenomenon of self-organization is conceptualized in complex adaptive systems theory (Choi et al. 2001) as involving multiple causal mechanisms: (1) interactions among the components of a social system (such as a group, an organization, a community, or a nation) and (2) between the system and its environment that (3) create, or generate changes in, more inclusive social units, which (4) subsequently constrain or enable the behavior of the lower-level components (Ellis et al. 2009; Juarrero 2002). In self-organization theory, the "system" is seen to change its boundaries over time, as in neo-institutionalism (Thornton et al. 2012) and coevolution theory (Baum and Singh 1994).

A second basic position on causal trajectory, more recent in origin, rejects the idea of stratification, regardless of whether boundaries are theorized as social constructions or real. This position is characteristic of situated action theory (Suchman 1987) and certain practice theories (Orlikowski 2000, 2002). Such theories eschew both micro-macro distinctions and the existence of boundaries between an affected entity and its environment. This theoretical bracketing excludes from focus external forces impinging on human actors and practices. Put differently, this view of causal dynamics has no "outside"—everything that matters is seen as occurring inside or within an entity (e.g., an organization) that is viewed as an analytic construct only, not as a natural system.

A third position on causal trajectory makes no significant use of the concept of stratification, but nevertheless implicitly assumes an inside and an outside. The affected entity is viewed as heterogeneous, consisting of mixed components such as people, organizations, ideas, and objects. These components are not theorized as belonging to different levels (e.g., micro and macro). However, the composition of the affected entity is seen to change, sometimes radically, over time from the accretion (i.e., importation, modification, and rearrangement) of new components that did not originally belong to it or from loss of preexisting components. This position is most clearly seen in actor–network theory (Callon 1986; Latour 2005). Although this view bears superficial similarity to ideas in complexity theory (Choi et al. 2001), neo-institutional theory (Thornton et al. 2012), and coevolutionary theory (Arthur 2009; Baum and Singh 1994), the emphasis of the third position is on the changing *composition* of the affected entity, rather than on *influences on the entity from within or from without.*

Below we elaborate on these three basic causal trajectory positions. We name the positions cross-boundary change, indwelling change, and evolving interlinkage.

Position II.A. Cross-Boundary Change

The position statement for cross-boundary change can be phrased as follows: Change involves influences across the boundaries of natural systems with environments or embedded units. The cross-boundary change position can be observed in a great majority of IS and related writings (for a particularly rich example, see Winter et al. 2014), and it has a number of distinct variants, including these three:[4]

1. **Upward Initiative:** Change involves movement from internal (lower level) to external (higher level).

2. **Downward Influence:** Change involves movement from external (higher level) to internal (lower level).

3. **Self-Organization:** Change involves movements back-and-forth across system boundaries.

[4]Arguably, the most frequent cross-boundary change variant in IS research might be called *same-level change*, in which the idea of a natural system entity (e.g., individuals or organizations) is implicit but the locus of causality is entirely internal to the entity. We omitted discussing this variant in the belief that it adds limited value to the paper.

Philosophical or Social Theoretic Foundations

The major warrants for the upward initiative variant of cross-boundary change are provided by philosophers considered to be individualists (Hollis 1994) and by social scientists who insist that macro social phenomena must be explained in terms of micro-level behavior (Coleman 1986). The position is well captured in this quotation from Weber (1968):

> Collectivities such as states, associations, business corporations, foundations … must be treated as solely the resultants and modes of organization of the particular acts of individual persons, since these alone can be treated as agents in a course of subjectively understandable action (p. 13).

In classic statements of individualism, the lower-level units are always individual humans. However, many social scientists view Weber's "collectivities" as stratified in themselves (e.g., corporations within nations), and much theorizing nowadays is devoted to the behavior of collective actors. This means that the position we call upward initiative can be adopted at several levels of analysis to theorize, for instance, the influences of departments on organizations or the influences of corporations on nations (Kaidesoja 2013).

The primary warrants for the downward influence variant of cross-boundary change come from philosophers and social theorists labeled *holists* or *institutionalists* (Hollis 1994). For holists, the behavior of collective social entities cannot be explained solely by, or reduced to, the behavior of individuals. For instance, Durkheim's sociology aimed to establish "social facts" (e.g., the suicide rate and its causes in social integration and regulation) that are specific to each society. Social facts affect and explain individual behavior, but do not result from individual behavior.

> A social fact is any way of acting, whether fixed or not, capable of exerting over the individual an external constraint [or] which is general over the whole of a given society whilst having an existence of its own, independent of its individual manifestations (Durkheim 1982, p. 59).

Holists allow that social structures grow initially out of human interactions, but they focus on the ways that social structures, once established, subsequently enable or constrain individual behavior through language, resources, and the material arts. A familiar example of the holist position is neo-institutional theory with its emphasis on the mechanisms (normative, mimetic, and coercive) by which social structures limit or support the choices of individuals and organizations (DiMaggio and Powell 1983). Thus, institutional theorists often focus on

downward influences (e.g., from nation states to organizations) (Wilber and Harrison 1978). As with the upward initiative position, the downward initiative position can be adopted at any level to theorize, for example, the effects of government regulation on the actions of organizations.

The major warrants for the self-organization variant of the cross-boundary change position come from systems theory (Mingers 2014) and complex adaptive systems theory (Choi et al. 2001; Merali 2004). Self-organization is often misunderstood as an exclusively bottom-up causal process, but detailed analysis (Juarrero 2002) makes it clear that self-organization comprises a sequence of mechanisms of different types, such as same-level interactions among system components, interactions between a system and its environment, emergence of new or modified higher-level configurations, and top-down influences by the emergent system on its components.

Examples from IS Research Literature

In an example of the upward initiative variant, Jarvenpaa and Leidner (1999) theorized that a group culture of "swift trust" can result unexpectedly in virtual teams composed of individuals with a limited history of working together and limited prospects of working together in the future. The authors argued that team members imitated the behavior that other members communicated in their first few keystrokes, and that responses in kind enabled members to trust their colleagues in the face of unreliable technologies, differing views of the tasks performed, and extra-team obligations.

The downward influence variant can be seen in Ramiller and Swanson's (2003) discussion of how IS executives respond to media "buzz" about various IS innovations like reengineering and client-server architectures. Ramiller and Swanson assumed that IS executives and their organizations act within a broader social milieu in which they become exposed to the "organizing visions" (created by IT vendors, academics, consultants, and the media) associated with IT innovations. These organizing visions have "careers" (that is, they change over time), and Ramiller and Swanson showed that IS executives' responses change over time as well, offering evidence of enduring or repeated downward influences. Had Ramiller and Swanson chosen to focus on the *origins* of IS organizing visions, instead of their *effects*, they may well have adopted the upward initiative variant, as did Robertson et al. (1996) in a study of institutional entrepreneurs seeking widespread social acceptance for a particular IS organizing vision.

The self-organization variant is exemplified by Nan and Tanriverdi's (2017) analysis of IS strategy. Component IT innovation and architectural IT innovation lead to the bottom-up effect of hyperturbulence in the competitive environment, which in turn redefines the opportunity for IT to contribute to organizational advantage in a top-down causal path (Nan and Tanriverdi 2017). In such instances, self-organization refers to the formation of order out of organizational interactions without external or higher-level control or coordination (Tanriverdi and Lim 2017). The self-organization variant is multilevel by definition (Nan and Lu 2014). In addition, most other instances of multilevel IS theorizing (Burton-Jones and Gallivan 2007; Lapointe and Rivard 2005) also exhibit the cross-boundary change position.

Position II.B. Indwelling Change

The position statement for the indwelling change position on the causal trajectory dimension can be phrased as follows: Change occurs through interactions within an analytically defined entity (i.e., an entity not viewed as a natural system). The entity is not differentiated into levels. There are no relevant external influences.

Philosophical or Social Theoretic Foundations

The indwelling change position rests heavily on the philosophical and social theoretic ideas that all social activity consists in the enacted communicative practices of individuals in idiosyncratic situations. Social structures (defined as abstract ideations like strategies, norms, and rules) are created and reproduced in action (Garfinkel 1967) and are believed to exist only as "memory traces" in the mind (Giddens 1979).

From this point of view, it is meaningless to theorize about external environments and forces acting on humans; the very idea of something "outside" the social activity of interest does not arise. This "inside-only" view of the social world characterizes several important articulations of practice theory (Orlikowski 2000, 2002).

An Example from IS Research Literature

Mazmanian et al. (2013) studied the use of mobile email devices in a workplace, theorizing that knowledge professionals enacted "a norm of continual connectivity and accessibility that produced a number of contradictory outcomes" (p. 1337).

> [A]s participants [in the workplace] individually managed their mobile email, they began producing

> and sharing assumptions regarding how professionals should be using mobile email to get their work done. Over time, these shared assumptions were reinforced and reproduced in practice, further raising expectations about when and where participants should be engaging with their email communications. These heightened expectations led participants to feel increasing stress (Mazmanian et al. 2013, p. 1345).

The authors portrayed this process visually via an ascending spiral mediating between the "collective" on the one side and the "individual" on the other.

Position II.C. Evolving Interlinkage

The evolving interlinkage position statement might be articulated as follows: Change occurs through the importation of heterogeneous new elements (e.g., ideas, actors, resources) into an entity (or loss of elements preexisting in the entity) and by the creation of new linkages among the entity's elements. The affected entity changes qualitatively in composition.

Philosophical or Social Theoretic Foundations

The major warrant for the evolving interlinkage position is actor–network theory (Callon 1986; Latour 1996; Law and Callon 1992). The term *heterogeneous* connotes actors and activities of different types (e.g., individuals, collectives, nonhumans), domains (e.g., business, government, academia), and/or geography (e.g., local, national, international). Whereas the indwelling change position theorizes about the emergence of change occurring within an analytically defined setting, the evolving interlinkage position focuses on the changed composition of the entity through the incorporation of new (or loss of old) elements.

An Example from IS Research Literature

Heeks and Stanforth's (2007) study of e-government projects presented a framework derived from actor–network theory, in which the major causal claim is that e-government projects cannot advance unless there is both a high degree of mobilization of local network actors and a high degree of attachment of actors in a global network. Their theory contributes insights on e-government success and failure by viewing e-government projects as an unfolding process rather than as a snapshot in time.

Additional Observations about Causal Trajectory Positions

Elaborated positions on the causal trajectory dimension are summarized in Table 4. Each position has authoritative warrants in the philosophical or social theory literatures. Each position can be identified in some published research in IS and other fields. The table contains constructed examples, based on Heeks and Stanforth, to illustrate the differences in the positions more clearly.

To our knowledge, the distinctions between the positions on the causal trajectory dimension have not been clearly discussed in the IS literature in a way that speaks to our entire community. The fundamental distinction among the positions lies in the conceptualization of affected entities and how change happens in or to them. In the cross-boundary change position, observable in the majority of IS research, change is understood as moving across the boundaries of real natural systems (e.g., from nation states to organizations or from workers to their employing organizations). By contrast, indwelling change occurs entirely within an entity whose boundaries are analytic only. Put differently, the entity is *not* viewed as a natural system that is embedded in an "environment." In the evolving interlinkage position, the entity (whether viewed as analytic or real) is seen as mobile: It changes qualitatively in composition as it imports new elements or diminishes through the loss of adherents.

Consider how exemplars of the indwelling change and evolving interlinkage positions contrast with the familiar cross-boundary change position. Above, we described the Mazmanian et al. study as an exemplar of the indwelling change position. When discussing whether their findings might be transferrable (see Lincoln and Guba 1985) to other settings, Mazmanian et al. wrote:

> Given that mobile technologies are increasingly pervading the lives of many contemporary workers, the shifts in practices and norms identified here … may well extend beyond the knowledge professionals we studied (2013, p. 1353).

This passage implies that conditions similar to the ones they observed might arise independently in other settings. The possibility of influences between the organization studied and other organizations or with something like "society" (external forces) is theoretically excluded in this account.

By contrast, others scholars observing similarities across organizations might adopt a cross-boundary change position, arguing that organizations acquire common norms of behavior

Table 4. Positions on Dimension II Causal Trajectory

Causal trajectory refers to a theorist's views about the causal movements of an affected entity in space and time. The illustrations below were crafted by the authors to parallel the position taken by Heeks and Stanforth (2007).

Basic Position	Elaborated Position Statement	Illustrations from the IS Field
Stratification Causality involves influences across the boundaries of a stratified entity	**II.A. Cross-Boundary Change** Change involves influences across the boundaries of natural systems with environments or embedded units. **1. Upward Initiative** Change involves movement from internal (lower level) to external (higher level). **2. Downward Influence** Change involves movement from external (higher level) to internal (lower level). **3. Self-Organization** Change involves movements back-and-forth across system boundaries.	• E-government initiatives succeed when champions in government organizations persuade external institutions to support their plans (Upward Initiative). • E-government initiatives fail because they encounter divergent public values and opinions spread by media, consultants, and vendors (Downward Influence). • E-government initiatives succeed when champions persuade external institutions to support their plans and when their interactions create a favorable ecosystem, which in turn increases the motivation of internal stakeholders (Self-Organization).
Internalization Causality occurs through interactions within an undifferentiated entity	**II.B. Indwelling Change** Change occurs through interactions within an analytically defined entity. The affected entity is not differentiated into levels. There are no relevant external influences.	• E-government initiatives succeed when creative interactions unfold among stakeholders.
Accretion Causality occurs through the growth and complexification of a heterogeneous entity	**II.C. Evolving Interlinkage** Change occurs through the importation of heterogeneous new elements (e.g., ideas, actors, resources) into an entity (or loss of elements preexisting in the entity) and by the creation of new linkages among elements. The affected entity changes qualitatively in composition.	• E-government success emerges through the progressive achievement of high levels of local network mobilization and global network attachment (Heeks and Stanforth 2007).

because of "social contagion" (i.e., contact with peers (Burt 1987)), because of downward influences, for example from technology vendors and the media, or because of "structural equivalence" (Burt 1987), that is "common fate," or shared environmental circumstances.

As another example, consider the Heeks and Stanforth paper we took as our exemplar of the evolving interlinkage position. Many other writings on the topic of e-government adopt the cross-boundary change position. Consider, for example, a paper, cited by Heeks and Stanforth, that proffered the argument that e-government projects founder when governments fail to specify their own objectives, relying too heavily on external vendors whose interests conflict with theirs:

> The first and the gravest mistake made by public institutions is their failure to specify the objectives of the project. The project is usually not sufficiently related to the overall goals of the organization and it is often, somewhat irrationally, expected that an ICT company will be objective in assessing public needs. A company given the job of conducting the system study, performs it in a way that suits its own interests, rather than those of the public purchaser, i.e., it subordinates informational needs to technology, sells the most expensive product or sells a product that makes the public institution dependent on the private provider for many years (Pawłowska 2004, p. 177).

This is an example of cross-boundary change theorizing, and it differs critically in its assumptions from that of the Heeks and Stanforth study.

Dimension III. Causal Autonomy

The dimension of causal autonomy concerns the theorist's views about the direction of causal influences between human (or social) actors and technology. This dimension has roots in philosophical debates over "idealism versus materialism"

as well as "determinism versus voluntarism" (Bunge 1996). Three basic positions on this dimension can be differentiated.

The first basic position on the causal autonomy dimension is that all outcomes of technology use can ultimately be traced back to people's goals, intentions, and actions, because technology is the instrument of human (social) action and a human (social) accomplishment. This position is illustrated by the observation that "Self-driving cars can never be autonomous as long as someone tells them where to go." Consistent with this position are functional and teleological theories (Falcon 2012) and the philosophy of (human) action (Juarrero 2002). In this view, human motives—human ideas, meanings, and reasons, that is, goals or intentions—can properly be theorized as causes of human behavior (Juarrero 2002) and social outcomes. In contrast, the attribution of responsibility to nonhuman entities is not appropriate.

A second basic position on causal autonomy is that technology, like other external physical conditions (e.g., geography and climate), influences human ideas and behaviors. The materialist point of view is usually attributed to Karl Marx (1818–1883), but this position also has contemporary appeal (Braverman 1974; Smith and Marx 1994; Winner 1978).

To the extent that technology creates necessities and constraints that influence or even compel human behavior—a situation of interest in law, as well as social science—human behavior can be said to be externally influenced or determined. The assignment of legal liability (i.e., responsibility) requires the attribution of causation to someone or something (Dahiyat 2010; Hoekstra and Breuker 2007). A particularly interesting question today is how theorists should deal with modern technologies and systems that can operate and even self-modify, post development, without continuous human intervention. Examples include automated securities trading, driverless cars, artificial intelligence algorithms, etc. Increasingly, lawyers and moral philosophers (Grodzinsky et al. 2008; Stahl 2004) are mooting the possibility of attributing responsibility (or "quasi-responsibility") for certain sociotechnical outcomes to algorithms instead of to their designers or users (Stahl 2006). Ultimately, a theorist's assignment of responsibility for outcomes is a causal position. As Stahl (2006) noted, "A first condition of responsibility is causality" (p. 208).

A third basic position on causal autonomy attempts to synthesize the materialism versus idealism dualism (Bunge 1996) by emphasizing the close and possibly inextricable interactions between humans and technology. Actor–network theorists (Callon 1986; Latour 2005) have posited the symmetry of humans and technologies in the course of social change. Other scholars have defended this position by arguing the ontological inseparability of technology (as the product of social action) and the social realm (Orlikowski and Scott 2008). Still others adopt this position for the purpose of theorizing about "collaborative" technologies (e.g., communication tools, groupware, and social media).

Below we discuss elaborations of these basic positions, which we call human sovereignty, technology autonomy, and relational synergy.

Position III.A. Human Sovereignty

The human sovereignty position can be stated as follows: Technology is an inanimate product of intentional human action and therefore only people (or social actors) can be viewed as causal (i.e., agents of change). People are ultimately responsible for the consequences attributable to technology use.

Philosophical or Social Theoretic Foundations

The idea that technology doesn't *do* anything and that only what humans believe about or do with technology matters is common in everyday reasoning. ("Guns don't kill people. People kill people." "We don't have a technology problem here; we have a people problem.") Ancient Greek philosophers provided some of the earliest recorded warrants for the human sovereignty position. Final causes (goals, intentions, or functions) were among the types of causes known to the Greeks. For Aristotle, it was important to identify a phenomenon's primary cause, which he believed in many instances was a final cause (Falcon 2012).

Champions of positive science attempted to eliminate human reasons from scientific explanation on the grounds that they cannot be observed and therefore should be ascribed to the realm of the nonscientific or metaphysical.[5] By contrast, idealist philosophers like Dilthey (1833–1911) insisted that

[5]Auguste Comte asserted that "Le caractère fondamental de la philosophie positive est de regarder tous les phénomènes comme assujettis à des lois naturelles invariables, dont la découverte précise et la réduction au moindre nombre possible sont le but de tous nos efforts, en considérant comme absolument inaccessible et vide de sens la recherche de ce qu'on appelle les causes soit premières, soit finales" (Comte 1830–1842). Translation (ours): "The fundamental character of positive philosophy is to regard all phenomena as subject to invariant natural laws, of which the valid discovery and reduction to the least possible number are the goal of all our efforts, while considering the study of what one calls primary or final causes as absolutely unattainable and devoid of meaning."

human ideas exist independently of the material world, and that human intentions drive action and the consequences of action. Among contemporary philosophers of human action, intentionalists recognize that intentions do not always result in the hoped-for outcomes (Von Wright 1971). Nevertheless, intentions are important, not only because they are distinctly different from Aristotelian material or efficient causes, but also because humans use their beliefs about intentions to ascribe responsibility for outcomes. Contemporary law, for instance, differentiates between manslaughter and murder on the basis of attributions about a perpetrator's intentions. While material and efficient causes can only be conjectured, intentions can be known by the agent (Wittgenstein 1958), and thus revealed by the latter.

A central concern of the contemporary philosophy of action is to distinguish between voluntary, involuntary, and compulsory human behavior (Juarrero 2002).

> Voluntary actions are both purposive and appropriate to the situation. Appropriate behavior *whose principle of movement or cause is within the agent*, *who is aware of what he or she is doing*, is paradigmatically "action" (Juarrero 2002, p.16; emphasis added).

To assign responsibility for action, Juarrero (2002) asserted, one must examine both the material conditions and the influential ideas that impinge on a person. In contemporary social sciences, Giddens (1979), among many others, has argued that human action is characterized by agency, that is, by the possibility of doing otherwise.

Examples from IS Research Literature

In a study of ERP system use, Boudreau and Robey (2005) argued that

> humans are relatively free to enact technologies in different ways. They can use it minimally, invoke it individually or collaboratively, improvise in ways that produce novel and unanticipated consequences. This perspective advises against treating technology as a determinant of social change. Rather, technology is implicated in social change at the discretion of human agents, even with automated manufacturing technologies and especially with computer-based information systems…. As users enact technologies in response to their local experiences and needs, significant organizational changes may result over time. From [a human] agency perspective, such changes are not realized from the embodiment of social structures within the technology (pp. 4-5).

Boudreau and Robey's case study of evolving patterns of use of an ERP system called Compass in a U.S. governmental agency illustrates the human sovereignty position particularly well, because ERP systems are generally believed to be quite inflexible. Thus, one would have expected to see relatively little freedom for Compass users to act differently than the system's designers and implementers had intended. However, Compass users deliberately and knowingly exercised their autonomy by *not* attending training sessions and by continuing to employ "shadow systems" long after Compass was implemented.

Position III.B. Technology Autonomy

The technology autonomy position can be stated as follows: Technologies can affect humans (or social actors) and (post development) can sometimes operate with limited human intervention.

Philosophical or Social Theoretic Foundations

The major warrants for the technology autonomy position come from philosophical writings on materialism. For materialists, explanations of phenomena, including human mental activities, originate fundamentally in physical conditions. The position that technology exerts causal influences on human behavior and societal outcomes is sometimes called "technological determinism" and is attributed (incorrectly, many experts say) to the writings of Karl Marx (1818–1883). More recently, the French philosopher and sociologist Jacques Ellul (1912–1944) deeply engaged the question of technology and social change and challenged the notion that technology is subservient to humans (Ellul 1980). Industrial and labor relations expert Harry Braverman (1974) attributed to technology the deskilling of craft work. Philosopher of science and technology Langdon Winner (1978) argued that technology embodies power relations and becomes a way in which societies settle political questions, thereby transcending the simple categories of intended or unintended consequences.

From the perspective of this position, technologies can take on a life of their own, once they have been developed and deployed, by virtue of ideology (Ellul 1980), economic interests (Marx 1887; Winner 1978), or operational independence from continuous human intervention (Sutherland 2008). Indeed, some classes of technology today are designed to actively *prevent* human intervention into their operation (Sutherland 2008).

Examples from IS Research Literature

"Most research on [decision support systems], knowledge management systems, and expert systems, focus [sic] on how these systems assist humans in decision-making" (Blue and Andoh-Baidoo 2010, p. 46). However, certain information systems, called "directive decision devices (Sutherland 2008) have the ability to not only gather data for input and determine the decision, but also enact the choice—all absent of human intervention" (Blue and Andoh-Baidoo 2010, p. 46). An example of directive decision devices is financial portfolio management systems that are intended to act when human investors fail to act within a predetermined timeframe (Fan et al. 2004). Similarly, Xiao and Benbasat (2007) observed that users of artificial intelligence-based product recommender systems cannot know whether or not these systems are actually doing the users' bidding.

Position III.C. Relational Synergy

We named a third common position on the causal autonomy dimension relational synergy. The position statement for relational synergy can be phrased as follows: The outcomes of technology use are the product of interaction between people (or social actors) and technologies.

Philosophical or Social Theoretic Foundations

The best-known warrant for the relational synergy position comes from actor network theory (Latour 1996). Latour argued that technology studies have traditionally emphasized technical attributes (i.e., an Aristotelian formal cause) in what he refers to as an "idealized materialism" (Latour 2007). Latour countered that technologies are not inert objects that social actors can manipulate at will, nor are they autonomous agents that exert their (functional) goals onto human actors (Howcroft et al. 2004, p. 345). Instead, Latour argued for a "material materialism," in which assemblages of humans and technology "actants" are theorized as concretely real actor networks, not just social constructions (Latour 2007).

Today, the leading theoretical statement on the material role of information technology in conjunction with human agency is sociomateriality (Leonardi et al. 2012). Orlikowski and Scott (2008) have advanced a sociomaterial perspective in which technology and society, while analytically separable, are ontologically "inextricably intertwined." Other IS and sociotechnical theorizing about the close synergy between humans and information technology include Schultze's (2014) discussion of "cyborgs," Ekbia and Nardi's (2014) "heteromated systems," and technology affordances and constraints theory (Majchrzak and Markus 2013; Markus and Silver 2008; Zammuto et al. 2007).

An Example from IS Research Literature

Leonardi employed the term *imbrication* to convey his theory that technology and the social world (i.e., social systems, social dynamics, and social processes) are ontologically distinct—but deeply interrelated—entities (Leonardi 2012). In his study of automotive crash testing simulation, Leonardi (2011) theorized that perceptions of constraint invite people to change their technologies, while perceptions of affordance lead people to change their routines. For instance, because the suite of finite element tools used by engineers to build simulation models did not produce consistent results (thereby constraining the engineers), developers

> recognized implicitly that their goals to make crashworthiness simulations more credible (human agency) could be fulfilled if they created code that would automatically aggregate simulation results into standard reports (material agency) (Leonardi 2011, p. 158).

Additional Observations about Causal Autonomy Positions

Table 5 summarizes the positions on the causal autonomy dimension and offers constructed examples based on Xiao and Benbasat (2007) for contrast. Each position has authoritative warrants in the philosophical or social theory literatures. Each position can be identified in some published research in IS and related fields, and each position can be advantageous for some theoretical purposes.

The human sovereignty position figures prominently in the literature on the social construction of technology (Howcroft et al. 2004). This position is highly relevant for theorizing about the origins of technological innovations (Van de Ven et al. 1999) and about the course of technology evolution over time (Pollock and Williams 2009). It is also advantageous for highlighting how managerial decisions and actions when implementing technology (e.g., the application of complementary technologies and process changes) shape subsequent technology uses and outcomes.

For an increasing number and diversity of technologies, including automated decision making (e.g., automated trading and insurance underwriting), robotic automation (e.g., self-driving cars and self-piloting drones), machine learning algorithms, and embedded systems (e.g., software in refrigerators),

Table 5. Positions on Dimension III Causal Autonomy

Causal autonomy refers to a theorist's views about movement of causal effects between human (or social) actors and technology. The illustrations below were crafted by the authors to parallel the position taken by Xiao and Benbasat (2007).

Basic Position	Elaborated Position Statement	Illustrations from the IS Field
Technology as Instrument Causal effects move from people (or social actors) to technology	**III.A. Human Sovereignty** Technology is an inanimate product of intentional human action and therefore only people (or social actors) can be viewed as causal.	• Recommendation systems improve the efficiency of human decision-making, but do not constrain or manipulate human decision makers.
Technology as Influencer Causal effects move from technology to people (or social actors)	**III.B. Technology Autonomy** Technologies can affect humans (or social actors) and (post development) can sometimes operate with limited human intervention.	• Recommendation systems screen and evaluate products for people; as a result, people cannot know whether recommendation systems are serving their interests or those of product vendors and platform owners (Xiao and Benbasat 2007).
Technology as Interactant Causal effects move back and forth between people (or social actors) and technology	**III.C. Relational Synergy** The outcomes of technology use are the product of interaction between people (or social actors) and technologies.	• It is impossible to differentiate human and technological contributions to changed organizational practices such as the deployment of recommendation systems.

the assumption that technology use involves continuous human intervention is no longer appropriate. It is estimated that well over 60% of financial securities and currency trading is now fully automated; the progress of machine learning is such that some experts predict the arrival of self-programming automated trading algorithms within the next 10 years (Beddington 2010). Fundamentally unlike historical factory automation, in which capital substitutes for physical human labor (Marx 1887), smart machines today are not only "informating" human cognition (Zuboff 1988), they are also removing human thought processes from the coordination and control of physical and knowledge work (Sutherland 2008).

In the IS literature, Kallinikos (2011) featured and developed the theme of technological autonomy, and Markus (2005) proposed a "technology shaping" perspective on the consequences of decision-technology use. The technology autonomy position does not deny either the human and social nature of technology or the role of human agency in technology conception, development, and deployment. Rather, the technology autonomy position bounds out, for theoretical reasons, the social origins of technology and brackets the subsequent and consequential influences of autonomous technologies on human or collective actors. Although discredited in the minds of many, the technology autonomy position still attracts the attention of historians and scholars of large-scale technological systems (Smith and Marx 1994) and it offers needed theoretical possibilities to IS design scientists (Markus 2005).

The relational synergy position has deep appeal for theorists interested in information technologies that rely on continuous human intervention and input. Examples include electronic communication systems, social media websites, gaming technology, augmented reality systems, and the like. This position highlights the dynamics by which humans and their machines emergently cocreate evolving joint activity patterns.

Discussion

The value of our framework of causal structure lies, we believe, in highlighting key aspects of theoretical choice and contribution for IS scholars. We first restate the distinctive characteristics of our framework and then discuss how our framework could and should be used.

Contributions of the Framework

The three dimensions of our causal structure framework are derived from the neurolinguistic analysis of the causality concept (Lakoff and Johnson 1999), the philosophy of language (Wittgenstein 1958), the philosophy of action (Juarrero 2002), and the philosophy of knowledge (Bunge 1996; Salmon 1998). The dimensions concern issues that are still contested and unresolved in the philosophy and social theoretic literatures. On each dimension, we articulated three mutually incompatible positions, *each* of which (1) has

authoritative warrants, (2) has advantages for some theoretical purposes (as well as disadvantages for others), and (3) can be observed in the IS and related literatures. To our knowledge, nothing like full consensus on these dimensions and positions has been achieved in any of the social sciences or humanities. Agreement exists only within invisible colleges united by a particular philosophical perspective, a particular theory, a particular method, or a particular empirical phenomenon. Across invisible colleges, dissensus is the norm. To us, this suggests that there is no one right way for IS scholars to theorize and that embracing theoretical diversity might be valuable for our field.

The causal ontology dimension addresses theorists' views about the nature of causality, independent of research methodology. The positions differ fundamentally on the question of whether causality is relevant only in a single case or only to an entire population of similar entities, and thus this dimension does not resolve neatly into familiar distinctions among process theories, variance theories, and combinations thereof. We showed that the very form of theoretical statements differs with a theorist's position on the causal ontology dimension, and that a theoretical statement derived from one position cannot easily be restated in another position's terms without violating the assumptions underlying that position. Each position offers the possibility of unique and distinctive insights into IS phenomena, but simple (e.g., additive) theoretical combinations across the positions on this dimension risk incoherence. Nevertheless, we acknowledge that alternative position statements might be defensible.

The causal trajectory dimension deals with a theorist's view of what is changed and how change happens. The most familiar position is that change occurs across the boundaries that separate a natural system (a person, an organization, a system, a community) from its environment. Two alternative positions do not make a distinction between affected entities and their environments and may even assume that no such separation exists. Despite this commonality, the two alternatives differ from each other on the nature of change—as emergent from interactions among people versus as compositional metamorphosis due to the accretion (or loss) of heterogeneous elements.

The causal autonomy dimension concerns the direction of influences between people and technologies. Our contribution here is to make the case for the technology autonomy position for certain IS phenomena when particular theoretical conditions are specified, for example, when the theorist's focus is on what occurs *after* initial technology development.

In short, our framework represents a different way of sorting IS theoretical elements than by epistemological perspective (e.g., positivism, realism, interpretivism), by theory purpose (Gregor 2006), or by the elements of earlier frameworks (Markus and Robey 1988). Next, we discuss how using our framework offers value to IS scholars.

Using the Framework

On the surface, our framework may appear to offer a recipe for theorizing:

> Choose one option each from columns A, B, and C. As long as your theory fits into one of 27 possible combinations of positions, you're home free.

In our view, nothing could be further from the truth, for several reasons.

First, we do not intend the framework to be a menu or taxonomy. Taxonomies are schemes for sorting empirical entities (in this case, IS theories) into buckets. Taxonomies prove their worth by covering all empirical entities and by classifying each entity uniquely. Instead, we propose our framework as an analytic device to help IS scholars envision theoretical alternatives while reading published articles, constructing and justifying theoretical arguments, and evaluating manuscripts. Although we are not adverse to appropriate recognition for our contributions, we do not wish to become an obligatory passage point (Callon 1986) for classifying and categorizing all future theoretical contributions in IS.

Second, our positions are inherently fuzzy. For example, the relational synergy position on the causal autonomy dimension can be understood either as meaning the absolute inseparability of humans and their technological practices or as meaning the close, but differentiable, imbrication of the two. How a theorist fleshes out a position on one dimension may have substantial implications for the logical possibilities on another. For instance, if one theorizes relational synergy and defines it as inseparability, then (it seems to us) only constitutive causality and indwelling change are logically possible on the other two dimensions. By contrast, if one theorizes relational synergy and defines it as imbrication, then all positions (as we have described them) on the causal trajectory dimension are logically consistent, and both causal mechanism and constitutive causality on the causal ontology dimension are logically consistent. Put differently, depending on how a theorist defines her positions on each dimension, there may be fewer than 27 logical combinations, or there may be more.

That said, we have three additional observations about combinations of positions on the dimensions of our framework.

1. *Some combinations seem to us to be logically incompatible*. One example is directional association and evolving interlinkage. The directional association position presupposes well-defined and stable entities characterized by clear constructs (Weber 2012). By contrast, the evolving interlinkage position assumes entities whose composition is believed to change, perhaps radically, through accretion (or loss) of components. For example, a business process that has been automated can be argued to offer qualitatively different affordances and constraints to organizations than its manual counterpart. It is difficult to reconcile this conceptual mobility of entities in the evolving interlinkage position with the assumptions of the directional association position. Another example is the combination of directional association and relational synergy, if and when the latter is defined as the inseparability of the social and the material (but not when defined as imbrication). The compatibility of any combination of positions will depend upon the theorist's elaboration of each position and their interrelationships.

2. *Some combinations seem to us to be theoretical scripts*, that is, ways of understanding the world that are familiar to the point that some scholars may engage them uncritically (Avgerou 2013b; Grover et al. 2008). One such theoretical script is the combination of directional association, cross-boundary change, and human sovereignty. This combination is observable in theories of IT–business value, such as that of Melville et al. (2004), in which managers' investments in IT resources (human sovereignty) are theorized as associated with process efficiencies that can lead to improved organizational performance (directional association), depending on influences from competitive and economic environments (cross-boundary change) and depending on complementary investments by managers in business process change, training, etc. (human sovereignty).

   Another theoretical script is the constitutive causality, indwelling change, and relational synergy combination, familiar in sociomateriality theory (Orlikowski and Scott 2008) and in theorizing about online language games (Fayard and DeSanctis 2010). An example is the study by Mazmanian et al. (2013), in which the phenomenon of interest—mobile technology use and knowledge worker accessibility—was theorized as occurring within an analytically defined social setting undifferentiated from an environment (indwelling change). Knowledge professionals' understandings of their behavior and perceptions of their autonomy coevolved (constitutive causality). While the professionals believed that smartphone use increased their autonomy, their constant accessibility eroded their autonomy, revealing the deep entanglement of technology use and professional aspirations and commitments (relational synergy).

   A third theoretical script is the causal mechanism, cross-boundary change, and relational synergy combination, exemplified in the study by Volkoff and Strong (2013), which explicitly invoked the causal mechanism position. Low-level ERP affordances such as data recording capabilities were described as enabling conditions that could (but did not necessarily) lead to organizational affordances such as operational monitoring and control (cross-boundary change). Although the authors theorized both organizations and IT as consisting of nested causal properties (relational synergy), they also noted that Leonardi's (2011) concept of imbrication offered a theoretical alternative (sequential alternations of human sovereignty and technology autonomy).

   By saying that these combinations are familiar IS theoretical scripts we do not mean to imply that they are somehow wrong or bad. Rather, we suggest that these theoretical combinations may at some point lose their ability to stimulate our collective imagination (Rivard 2014; Weick 1989) about alternative theoretical possibilities. According to Weick (1989), theory cannot be improved without improvements in theorizing. The way to improve theorizing, Weick argued, is by generating numerous "thought trials" and by progressively, through an evolutionary selection process, winnowing them down to ones that are retained. The key is to make these thought trials as heterogeneous as possible, so that "a broader range of possibilities" is tried (Weick 1989, p. 522). But Weick also noted how difficult it is to achieve that goal, because of the human tendency for "grooved" and redundant thought.

3. *Some combinations seem to us to be plausible, underexploited, and potentially advantageous for certain research purposes*. IS scholars may find opportunities to create new theoretical contributions by exploring unfamiliar combinations of positions on the dimensions of our framework. Three in particular seem to us to be fruitful. First, we believe that all theoretical combinations involving the technology autonomy position have been underexploited but could be useful in the case of "autonomous" technologies. The second is constitutive causality and cross-boundary change. The third is directional association and indwelling change.

   As noted above, constitutive causality, indwelling change, and relational synergy is a familiar combination, and indeed, if one starts with the assumption of indwelling change, the only compatible position on the causal

ontology position is constitutive causality. However, we believe that constitutive causality can pair equally well with cross-boundary change and evolving interlinkage. An example of the former combination can be seen in Bjørn and Ngwenyama (2009), whose theory we would characterize as a combination of constitutive causality, cross-boundary change, and human sovereignty. Their theory of virtual team collaboration explicitly addressed the building of shared meanings at three levels of analysis: the human lifeworld, work practices, and the organization. Their premise that translucence in communication at all levels has consequences for the projects that virtual teams perform seems to us to embody the cross-boundary change position. Bjørn and Ngwenyama's focus on the emergence of work practices through the interaction of meanings and actions is a constitutive causality account. The failure of virtual team members to adapt or engage groupware tools at various moments in their practices suggest that Bjørn and Ngwenyama adopted the human sovereignty position.

It also seems to us that the directional association position can be combined with indwelling change, in addition to the more familiar cross-boundary change position. Consider Beck's (2014) theorizing about globally distributed information systems development and new product development projects. Beck theorized that project success depends, not on geographic distance, but on the sharing of professional norms among offshore outsourcers and their clients. This is a directional association argument. At the same time, Beck focused on the enactment of professional norms within the project world, uninfluenced by external forces (e.g., organization or national culture); this exemplifies the position of indwelling change. Beck's view that project members decide which groupware tools to use and how to adapt them is a human sovereignty argument. Naturally, theorists could adopt the view that enacting global professional norms is costly. Offshore outsourcers need to ensure that communication and cultural issues do not become barriers to success (Ravishankar et al. 2013; Vial and Rivard 2016). Such theorizing would posit the influence of external social influences (cross-boundary change) counteracted by outsourcers' actions.

In short, we see the contribution of our framework as an aid for IS scholars in addressing four of Rivard's (2014) eight "ions of theory construction." It is an aid to *presentation* by showing how and why the forms of theoretical statements do—and indeed should—differ depending on the theorist's causal assumptions. It is an aid to *cohesion* by reminding authors to argue and justify the linkages among their causal assumptions, which may be particularly important when attempting to combine theories with different causal structures. It is an aid to *imagination* by illustrating the diversity of causal assumptions and the possibility of alternative combinations. And it is an aid to *contribution* by suggesting the potential value of underexploited positions and combinations of causal assumptions. Finally, our framework may also be useful in synthesizing existing knowledge on a particular phenomenon of interest (Rowe 2014; Schryen 2015). Although the framework may never result in a unified theory of an IS phenomenon, it may be a way to construct research gaps and to problematize the literature in the service of future theory building (Alvesson and Sandberg 2011).

Conclusion

Lyytinen et al. (2007) argued that the

> primary criteria on which to judge the quality of the article in [technical or scientific universities and business schools] include its empirical foundations, the clarity of formulating the research question, the infallibility of the research design, and the degree to which the evidence leads to an undeniable conclusion about causality (p. 321).

They opposed these criteria to those of the classical European tradition, according to which criteria of

> the quality of the philosophical article include comprehensiveness of the underlying literature, careful disposing of alternative explanations, the vividness of the argument, and the care exercised in spelling out the logic to reach the conclusion (Lyytinen et al. 2007, p. 321).

We believe that such an opposition between science and philosophy is inappropriate for the IS field. Our field was founded on the intuition that information technology is consequential for individuals, organizations, and beyond. If we are to answer the question "Is information technology changing the world?," we will require a far more sophisticated conceptualization of causality than is offered solely by reliance on empirical methods and evidence. Reasoning about causality is central to IS theorizing. Methods are not infallible, they should not take precedence over theory, and they are not the sole path to causal insights. Philosophy is more necessary than it seems (Rowe 2018). It helps unravel complexities about causation that are by no means settled and cannot be addressed in an instrumental way.

In this paper, our aim was to deepen and expand collective understanding and appreciation of IS theory through a focus on *causal structure*, defined as a theorist's implicit assumptions or explicit statements about the nature, origins, processes, and outcomes of sociotechnical phenomena. The dimensions and positions of our framework are warranted by the literatures on philosophy and social theory, but our framework does not represent an opposition between "old world philosophizing" and "new world science," in which science is seen as the search for causal relationships in empirical data, and philosophizing is seen as reasoning and argumentation (Lyytinen et al. 2007). Instead, our framework strives to reveal the diversity of options available to IS scholars in developing causal theories and the value to be unleashed by embracing this diversity.

Throughout the ages to the present day, philosophers and social scientists have sought to identify and label patterns in social behavior, to attribute responsibility for the outcomes observed, and to inquire about causality. As we IS scholars follow in their footsteps, we should learn from their achievements while continuing to explore the changing sociotechnical landscape.

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