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Process Theory: Background, Opportunity, and Challenges

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Process Theory: Background, Opportunity, and Challenges

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ABSTRACT

The IS field has the opportunity to address a new range of questions and phenomena by expanding its attention to process. This monograph provides a taxonomy of various types of process based on level of agency by actors in initiating and carrying out the process as well as degree of adherence to action sequence planning. It also frames the discussion in terms of theory and the value of expanding the study of process in a theory representation and testing cycle. Numerous forays into process examination in IS are presented and critiqued. Discussions consider Process Virtualization Theory, Pentland's path structure and process grammar ideas, and process mining. Roadblocks for scholars and editors interested in expanding the IS field's use of process theory are also detailed with recommendations provided for addressing them. The monograph is intended primarily for IS doctoral students who have an interest in how and why computing by people works as it does.

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The Need for Process Theory in IS

The purpose of this monograph is to promote the use of process theory as an essential part of the body of knowledge relative to IS which should be nurtured and expanded. To do this I will address why process theory is important, how it can potentially enhance the discipline, and what needs to be tackled to make the development and application of process theory routine and useful.

To some extent this monograph is about vocabulary. Terms such as process, theory, and information systems will be considered in significant detail. In addition to a definition, I will present a taxonomy of fundamental and distinct types of processes which might logically be observed in the IS practice and research domains. By "theory" I will be discussing the elements that comprise theory as well as the context in which it is applied. The preponderance of reference to theory will be as it exists as a component of a particular version of scientific method that alternates composing statements or other representations (theory) about the empirical world and testing them through observation or experimentation. Clearly this is not the only way the term theory is used and some alternative formulations will also be considered. The definition of information systems is also one for which there is no single consensus. Thus, I will try to make clear what I mean when using the term and, by implication, what I see as the central tendency and boundaries of this as one among many fields of practice and academic study.

The goal of this first section is to convince you that process is an intricate part of the domain of IS in practice and, therefore, in research. The foundation of this argument is that process is a fundamental element or way of looking at phenomena of all types in our "real world". Specifically, it is found extensively in the domain of information systems, which focuses on the range of issues pertaining to interaction between people and computing technologies (Sarker *et al.*, 2019). Examples where process theory can be used in IS will also be presented.

Building any sort of theory is itself a process (Weick, 1995). In this monograph, every effort is made to de-mystify and simplify our understanding of creating and testing process for the purpose of accumulating knowledge (Niederman, forthcoming). A common view of building theory among academics is that this must be a difficult process. A different approach will be explained where creating and testing theory is straightforward, however, finding well supported robust theories may require the accumulation of significant effort. In essence, I emphasize the distinction between theory per se and the amount of support a theory has earned as an attribute of that theory, not as necessary for its existence. Thus, every effort is made in this monograph to lower barriers to entry for theorizing, by simplifying and normalizing procedures for getting started, acknowledging that some theories may be quickly supported, and others may take extensive efforts.

The approach of proposing then testing theory, follows Popper's (1980, 1992) description of scientific method. It relies on the concept of "convergence" – that statements can come closer and closer to representing and explaining entities and relationships in the world. This is entirely consistent with Deming's (2000) concepts of constant improvement. Arriving at universal unchanging truths[1] requires a "real world" that is also permanent and consistent across locations. Convergence, however, assumes not only that we can come closer to universal permanent truth

[1] I use the term "truth" with the humility of believing that there may or may not be a single "truth" applicable everywhere throughout time; nor that if there is

where (and if) such exists, but also that we can track with observation and updating of theory our best approximations as underlying reality evolves and our understandings mature. Following this reasoning we may expect at times that increased diversion of our understanding from our observation may be a very useful indication of underlying change and an opportunity to significantly enrich our accumulation of knowledge through new investigation. The role of theory, then, is to describe our current level of understanding while over time providing an opportunity to discover additional deeper truths about those trajectories of change.

In IS in particular we can expect underlying realities to change. We see very clearly the continual evolution of technologies in their capacities, the range of affordances to which we put them to use, the ways they are built and maintained, and how we see ourselves as tool-users. We have tended to measure many entities or constructs at a point in time even while knowing that they may be in constant flux or progressing in a particular direction. For example, a variable like "user satisfaction" may be a convenient summary of the attitude of a computer user at a particular time but we would be very surprised if this did not change if in the next time period a massive system failure occurred. Conversely, if a difficult to use feature is simplified by automating difficult steps, satisfaction should increase significantly. A set of users may shrink with employee attrition and thus the average and sum of satisfaction may statistically change even if zero of the remaining users change at all. As a result of change among variables, relationships between variables can also be expected to change. It is possible that as satisfaction rises and falls, use will rise and fall with it; but perhaps satisfaction will rise because automation removes the need for use and with rising satisfaction levels, we see falling actual use. One approach is to study phenomena over periods of time in the sense of longitudinal studies, but even here we are generally extrapolating or assuming the values between measurements. Expanding the frequency of measurements and the time horizon over which they occur can be expected to provide more exact

one I know or am capable of knowing what it is. However, I do believe there are many statements or representations that are clearly NOT true and that not every statement is equal in truth value.

descriptions of the patterns of change. Note that longitudinal studies vary from observation of cohorts or the same participants to those of different samples from the same population. A research question requiring the use of a cohort may just not be possible. A study of college freshmen in 2015 followed by another in 2020 will both study freshmen but probably nearly entirely different people. So, we may never know how the 2015 college freshmen have evolved in their facility with computing skills; but we may be able to see how newcomers to college as an entity have changed. In this sense longitudinal studies may investigate changes in the entities being scrutinized or may reflect other dynamics such as changes in high school curriculum, availability and cost of access to computing, or new affordances and features that change the nature of operating computer technology.

The opportunity to return to either a cohort or a new group in the same role is not always available for researchers. As a result, we often study states at a particular point in time inferring that relationships exist even though we cannot know from a single study whether these are consistent across setting and persistent over time. While inferences based on observed relationships at these single points in time may present strong argumentation for the existence of observed relationships, the evidence should not be viewed as "proof" but rather as an opportunity to propose generalizations which may lead to future verification or refutation. This theorizing process when engaged by a community can provide testing and refinement over time in order to reveal progression of the best-known truth at the moment. They can also show the trajectory of changes over time. Such community investigation may be by design initiated by National Science Foundations or the like who guide this sort of research through their selective investments, or by the "marketplace" of independent scholars individually choosing to follow paths based on their own preferences and criteria.

The existence of change and primacy of time and timing motivates this larger interest in acknowledging in a substantial way the centrality of non-permanence in IS phenomena. It also suggests that studies over time may surface that are robust when tested but are contradictory when compared. It will be a challenge for researchers adding a time component to their thinking to consider whether the initial or follow up findings are "wrong" or if their differences represent a way to understand how the underlying reality has changed. It may be that in follow up studies, researchers need to consider other environmental changes as a sort of control variable and/or enhance their interpretive capabilities to suggest the range of possibilities regarding how underlying relationships may have changed. Note that where results are consistent from one time period to the next, there is no guarantee that offsetting changes may not have occurred which cancel each other out. Additional approaches to cohort longitudinal research as well as follow up studies addressing the same general research questions should be welcomed to extend our ability to address issues of knowledge evolution. Extending these approaches calls out for a direct engagement with process in its multiple forms.

In this monograph, I elaborate on the nature of theory, process, and their application to IS knowledge. I also acknowledge that we do not yet have an easy infrastructure for investing fully in this type of research and hope that this monograph provides an initial piece around which the many pieces of infrastructure which are needed can be created.

This monograph is aimed primarily at doctoral students, early career academics, and any other scholars who have not had a chance to focus on process as a component of their conceptual tool kit. I aim at situating this discussion in the field of IS, but hope that others in related areas may also find it useful. In this sense it is intended to be helpful for those who wish to use process theory in their own research but also for those wishing to confidently review, promote, or just understand work in this area. It is hoped that this monograph will serve as a basis for invention of new process theory and new tools for creating, testing, and evaluating such theory.

Information Systems Domain

In the next sections, I will address the nature of theory and process. First, however, I wish to clarify what I mean by the information systems domain.

Sarker *et al.* (2019) has described a guiding continuum for various approaches to what should be included in IS as a field of study. To the extent that IS has a central tendency of human interaction with information system computing, research can focus on this interaction or on either of the two main ingredients focusing more predominantly on one or the other.

For the most part, I follow the description of the discipline of IS described by Sarker *et al.* (2019). This view holds that the interaction of technology and humans is the central tendency of the domain. This would include a socio-technical aspect (e.g., Checkland and Scholes, 1999; Mumford, 2006) where both social and technical issues can be studied independently with the assumption they will be studied simultaneously or in sequential iterations and their mutual influence recognized. Similarly, a sociomaterial view (e.g., Kautz and Plumb, 2016; Mueller *et al.*, 2016; Orsatti *et al.*, 2016) highlights those social and technical issues which are inseparable, in the sense that grades cannot be viewed solely as a function of student or course, but emerge from a particular student taking a particular course (e.g., a dependent entity, following Hawryszkiewycz, 1988, p. 140). In this view the actions themselves are the center of attention with actors participating as attributes bringing their particularities but not determining the nature of the interaction, particularly its emergent qualities. Both socio-technical and sociomaterial conceptualizations can be characterized by the interaction of human and tool; by the potential for change or manipulation of human and/or technology. For example, where users interact with an ERP or cloud computing environment, they can change settings, add new features, discover new affordances or applications; they can also be changed by the new technology configuration in terms of their preferred criteria for judging system utility, the new abilities they learn; and their new attitudes toward the systems. Users change the system and are in turn changed by it (potentially in *any* encounter between the two, though not necessarily in *every* encounter) in a sort of co-evolutionary dance.

Spreading out in one direction from this central tendency are issues increasingly belonging to the social realm. An intermediate study might view how humans react to a fixed technology. For example, how a user reacts to a particular virtual reality display. A study further from the central tendency might investigate the building of trust among computer game players or how stock markets react to technology investment announcements. Spreading in the other direction, issues increasingly are solely in the realm of technology. An intermediate study may look at how users react to varied response times in computing performance where a study even further from the central tendency examines varied techniques for recovering backed up data. It is not to say that studies moving toward the periphery of IS are less important by their nature, only they are less clearly members of the set of IS studies. There has been much debate within the IS community about where, if anywhere, edges on the field should be set (e.g., Agarwal and Lucas, 2005) with some arguing that a field without a strong core will be "hollowed out" and others that not extending as far as possible will constrain the field and keep it from exploring areas where its attention could be useful.

Another way of looking at IS would be through an historical perspective. Arguably IS commenced with the invention of computing devices and proceeded through a series of phases loosely described by the dominant platforms of the time (Hirschheim and Klein, 2012; Niederman *et al.*, 2016). From this perspective, we might trace the evolution of IS in terms of its stakeholders. In early days developers and users were largely limited to members of organizations. The IS department came into being as computing broadened from only supporting accounting departments where many were largely housed in early days to supporting the range of organizational functions including marketing, human resource management, and operations. In a sense the original constituency of IS offerings were members of these IS departments in a way analogous to people in organizational marketing departments being the stakeholder for marketing studies. To some extent marketing research has transgressed that boundary by examining more generally consumer behavior but largely the structuring of products, their pricing, and sales have continued to serve the marketing function. From the beginning, however, the phenomena of IS pertained to content outside of its own domain. Rarely, if ever, did organizations invest in IS for its own sake, but rather as a way to facilitate more effective and efficient accounting, finance, marketing, production and the like. Although there is a central core for the IS department to support an information infrastructure, the bulk of its work comes from collaboration with others. Computers themselves, once confined to large air-conditioned clean rooms, escaped into the general populace with a brief stop at department computing and mini-computers followed by a total jail break with desktop, laptop, and now mobile devices. Thus, the interaction of computing equipment and people is now ubiquitous throughout society, noting the continued unequal distribution due to a "digital divide". The interaction of the affordances of computer gaming and private users is arguably as relevant to IS as is the interaction of organizational users with enterprise systems. A danger is the potential for the IS research community to look at general issues and lose connection to and support of those who remain in organizational IS departments.

At each stage recognized by Hirschheim and Klein (2012) the technology capability, the installed base, and the invention of new affordances increases total complexity (though through standards at times also reducing the experienced complexity). In part this is because the new generations were largely added to rather than completely replacing earlier ones. People actively buy, install, use, and recycle an increasingly diverse array of computing devices. IS, as a result, can seem like an inevitable wave of progress that happens to us, yet this feeling does not render us completely without choices that we can invoke in our own worlds; or without influence through the collection of such choices made by clusters of individual decisions.

Debates in the information systems field have included the proposition that to be within the IS sphere, research must include a particular artifact. Thus, the way that a user interacts with an Android mobile device would be included; but something like sources and effects of trust might not. No one, that I know, argues that IS research should *exclude* artifacts and scholars are not unified on what constitutes an artifact – does it need to be comprised of hardware and software? Can it include creation of a policy or as we discus in this monograph an intervention or constructed process? Does it need to be whole and functional or can it be a component of another program or general but not implemented algorithm? Clearly reference to an artifact that is obviously an instance of an information system or technology is a strong argument for inclusion as IS research, however, the borderline is at best fuzzy and perhaps undrawable.

The IS field logically addresses a number of levels of units of analysis. These span individual tools and techniques, for example comparing the viability of using word processing versus spreadsheet software for writing technical reports; individuals in terms of choices of technology, ability to use or learn new procedures, and effect on individuals of the diffusion and adoption of technologies and practices. The IS department may be constructed differently, have varied responsibilities, and be more or less outsourced depending on the organization, but clearly from the beginning IS research addressed this level of analysis.

Within functions of an IS department, system development includes processes for gathering requirements, developing architecture, writing code, testing code, porting to production devices; routine operations include processes for identifying input, entering input, changing input to intermediate states; storing and retrieving data, displaying transformed data/information, applying results of processing to task performance; and implementing new systems includes processes for acquiring packaged software, installing and customizing packages, using systems in anticipated ways and adjusting them for innovations, retiring or renovating old systems. A quick look at any systems analysis and development textbook will include these and dozens of additional processes at increasing levels of detail.

Management of IS is often included as part of departmental IS, focused on issues addressed by the Information Technology International Library (ITIL) to include: rolling out new systems, providing training, troubleshooting, controlling expenditures and making commitments as well as managing specialized IS personnel. Such management issues include working with vendors and relationships with the members of other organizational departments, largely as users of IT, but at times as collaborators for distributing capabilities and generating new assets. Extending this view, IS as a component of the organization as a whole represents a target for IS concern. Organizational attributes such as level of investment in IT, how such technology is implemented, and net agility, resilience, and/or absorptive capacity in their own right, compared to other firms, or in relation to economic indicators like profitability or positioning in markets, are also generally viewed as part of the IS domain.

Computing in society refers to interactions between humans and computing outside of work and organizations (e.g., games, social networks). Frequently such investigations hold technology constant or treat it as a large black box (e.g., the effect of "internet" on politics) without regard to the specific character of the technology and alternative choices about its structure. As a result, studies of this sort move toward becoming pure psychology, social psychology, or sociology studies about humans and society where computing is an added fact of life rather than participant in the phenomenon.

Privileging Variance Theory

Process theory can be viewed as an alternative meta-theory to variance theory (Niederman and March, 2019a). Neither is theory per se following our definition of theory as a set of statements that can be used in a scientific constant improvement process of theorizing and testing. However, it is "meta" in the sense of providing structure and guidelines for a family of theory instances each related to particular phenomena. Each theory instance inherits significant norms, procedures, definitions, and characteristics from its meta-theory.

The preponderance of theory in IS research to date has been in the variance meta-theory family. A wiki page devoted to IS theory (Larsen and Eargle, 2020) lists 122 theories found in the IS literature. Nearly all of these are borrowed from reference disciplines such as psychology and communications (Moeini *et al.*, 2020). Borrowing theory from other disciplines enables the relatively smooth transfer of additional infrastructure such as connections between theory testing and evaluation, but it also short circuits the building of theory based on direct observation of information systems phenomena, which may be quite fragile upon their first presentation but hold the prospect for improvement with testing and reformulation.

Numerous IS studies are atheoretical, including some using grounded theory methods, the purpose of which is to build theory (Wiesche *et al.*, 2017). DeLone and McLean's (Petter *et al.*, 2013), extensively used model/theory[2] of IS success exemplifies this. Although the success model can be viewed as a theory in predicting relationships among key constructs, the many underlying studies on which it is based often begin with particular variables rather than an intention to test the overall structure. In this model several constructs, each of which is "comprised" of many possible variables which alone or in combination can represent the factor, sequentially influence outcomes.[3] System quality, for example, influences use (amount and quality) which in turn influences outcomes. This model identifies dozens of specific precursors as well as success measures and, essentially, provides the opportunity for scholars to use subsets of these measures (with some rationalization for which are selected) to investigate new standalone technologies within the common framework of larger factors. A measure of system quality, say throughput, would show variance among systems where faster throughput statistically generates more use (or perhaps more quality use in terms of a greater array of features being used).[4] This is followed by studying the relationship of varied use with outcomes such that more or better use leads to individual outcomes such as higher productivity, more satisfaction or organizational outcomes such as more compliance with regulations or superior economic results.

Let us suppose that this model could be fully supported by results consistently showing the strength and direction of these relationships.

[2]Some scholars, notably Weber (2012) draw a strong distinction between model and theory. Weber indicates that a theory without much support can be called a model. This implies that amount of support is part of the identity of a theory rather than an attribute likely to change frequently. It also doesn't specify how much support is necessary and whether a formulation must be decommissioned as a theory and returned to mere model status if a new study shows refutation. I prefer to think a model is a theory without the relationships specified. We see frequently in nomological nets lines between the entities, but without a specification what the lines/relationship mean.

[3]Note that at times DeLone and Mclean refer to this as or partly as a process theory in the sense that they conceive the model/theory as a one way progression. I would counter that each construct in their theory is neither an action nor an event, so in one sense it is not a process, but tracing a particular instance through these stages may result in the observation of a process.

[4]Ironically, such increased use could potentially lead to slower throughput.

While there is value in knowing that a superior technology will lead to better results, it does not tell us (1) how to make superior technology; (2) what to do with the exceptions where superior technology does not lead to better outcomes; and (3) what agents have to do (or avoid doing) in order to achieve these outcomes. In other words, while there is value in understanding these relationships, there remain deeper questions the answers to which would be valuable additions to the IS body of knowledge. These questions supplementing those addressed by variance models involve making or doing – in other words actions managers (or others) can take. As a result, answers to these how and why questions, in addition to providing understanding promise to be useful in practice providing guidance regarding which actions are likely or unlikely to prompt desired outcomes.

Consider TAM and UTAUT. Fully accepting this as a robust theory across varied environments and technologies, the model does not address the sort of questions noted above. It does not address, for example, how a manager given a set of users and software applications makes them more useful, makes them easier to use, changes intentions into actual use (or predicts which of the population will so transform)? Nor is there embedded in the theory a feedback loop since, obviously, actual use should influence ease of use (if one comes down a learning curve) or perceived ease of use if one learns that the technology is a "dog" and will never perform well. Note that adding a feedback loop necessitates that we think of influence moving in both rather than a single direction. A dynamic theory would address mutual influence of variables where each is both independent and dependent and how they change together over time. Process theory would add the dimension of considering interventions and whether they are capable of shifting values on any or all of the constructs.

The use of variance theory is a reasonable way to provide positive value. After all, if it turned out that ease of use does NOT affect intention to use, why would anyone be motivated to find ways to make technologies easier to use? Addressing "how and why" questions is a logical follow up to extend our knowledge about these relationships and, I assert, process theory is an approach that can address these sorts of questions.

Once a relationship is broadly established by variance theory testing, we are faced with a combinatorial explosion of new how and why questions. We can get into a self-imposed paralysis if we follow the logic that: to understand a process we must understand its subprocesses and each possible variation; but to understand the subprocesses we must understand their sub subprocesses and each variation – all the way down.[5] But on the other hand, we can look at this uncountable number of combinations as an exciting "wild west" looking to be tamed. Just as we use the concept of "construct" as a shorthand for the many variations among instances comprising the construct, we can use aggregations of instances in process theory. For example, we can use "agile method" as a shorthand for the rich variety of techniques and activity sequences that must be included as instances of agile methods. If we can establish in rough terms that "agile methods" provide advantages relative to traditional ones, we can drill down to look at particular methods such as Scrum or eXtreme programming and at an even more granular level look at particular sequences of actions that are harmful, helpful, necessary, or irrelevant to achieving success or simply implementing a program using agile methods. Further, using process theory may be conceived as a flow between close examination of human actions toward a technology or tool including their responses to system actions and pre-conceived interventions intended to generate particular system outcomes. Such an examination may focus on changes to the technology itself (e.g., settings, adding data, connecting to other equipment); changes in the capability of the user (e.g., training, discovering new combinations of features, inventing affordances); and changes in the goals and evaluation criteria (e.g., upward as new possibilities are discovered, and downward in light of perceived constraints). Interventions may follow up regarding development of particular action sequences for manipulating technology; changing user skill levels and learning, and evaluation of goals and interim levels of achievement. Such interventions may be viewed as a unit and tested for effectiveness, or examined at a finer level of detail considering the actions, their durations, and

[5] This refers to the famous tale of the individual who explained that the earth stands on the back of a turtle. Where does this the turtle stand? On the back of another turtle. And that turtle? It is turtles all the way down.

sequence to seek understanding and improvement of the interventions themselves.

Even a relatively straightforward technology like a data entry system may be subject to many pathways or patterns of device, user, and task changes for individual users. It remains to be seen if there are combinations and routes by which more effectiveness and value are extracted from the user-technology partnership. Such questions are likely to have great value for those developing technology and those transferring it to users. Answers to these questions are likely to focus on actions and processes that IS managers, personnel, and users can.[6]

IS can only benefit from an additional focus on action-related questions. Actions especially purposeful or intentional behaviors reside at the heart of creating particular outcomes including the design, creation, distribution, and maintenance of artifacts (including those included in information systems. Studying individual or organizational actions can lead to insights into basic units of change – examining the results of activating a software feature, creating a new security setting, or patching an ERP flaw which generated workarounds, can be enlightening.

I urge each scholar to decide that the time is *now* to explore, develop, and exploit meta-theories, particularly process theory, that extend our knowledge beyond the constraints of variance theory.

Change or Substance – Why Not Both?

The idea that substances and process are equal and worthy of studying together is at least as reasonable as building a processual world where it is viewed as privileged above substance. Integration of substance and process can occur in single studies as posited by Ortiz de Guinea and Webster (2017), or in a scholar or program's research

[6]I use the term action to denote something that an agent does actively and usually intentionally. In contrast an event is something that "happens to" the agent. The same activity involving multiple agents can be an action for one and event for another, as I would take an action to call home where the individual answering would experience the event of the telephone ringing. The term activity is used to signal an action/event without specifying the role (initiator or recipient) of any particular agent.

stream, within a particular journal's inventory of work, or across a discipline.

On the other hand, focusing solely on process provides a counterpoint to those who maintain that only substance is meaningful. Evidence that process can be studied and that the fruits of such study are valuable may displace the view that only what can be seen, touched, and measured is "real". Attending solely to issues of process and ignoring substance offers an avenue of investigation promising new insights. Reconsidering the trajectory of the diffusion or adoption of a particular information technology as a series of events rather than as a single curve, promotes consideration of events that occur at each inflection point affecting the final shape but, even more importantly, suggests the question: what actions can be taken by vendor, client, regulator or other stakeholders to accelerate or inhibit progress.

For those who take the more extreme position that *only* change is important (that substance is not important because it is always only temporary), I suggest considering the use of time from multiple perspectives. Consider that some experiences occur over such a large time horizon that for all effective purposes they appear to be unchanging. The Andes Mountains appear to be more or less the same from one day to the next. From an airplane, the remains at Machu Picchu are probably at the same longitude and latitude as they were when I visited 10 years ago. The trails are probably still more or less in the same location, even if their surfaces may have been paved or the pavement deteriorated since my visit. Depending on which time horizon we choose, everything is constantly in flux, all remains identical before and after viewing, or there are observable but manageable changes.

Where the time horizon is large enough that no change is observable, what is the harm in treating entities as if they were permanent? When change is observable but manageable, for example when a user's facility with a software package changes slightly with each use, we are likely best served by considering some entities as if they were permanent (e.g., many attributes of the user and of the technology) in order to focus on the particular changes of interest; and sometimes when all is in flux we may need careful observation of the phenomena even to recognize what substances are important and in what ways they may change.[7]

Although some studies may emphasize substance, process, or both, the insistence that only substance, process or both is legitimate is to handicap the discipline to a reduced subset of the interesting research questions that can be addressed. There is potential value in studies that consider only substance, only process, or the two combined in various ways. A priori there is no certainty in regard to which view will provide the most valuable insights, so why choose one of multiple paths – or even better why not look at the phenomenon from each of these perspectives?

IS as a Science of the Artificial

In a larger sense, a distinction can be made among three foci of science, the physical, behavioral, and artificial with clear central tendencies but where the boundaries may be fuzzy. Studies of the physical sciences pertain primarily to substances and the forces that influence them. This would include physics, chemistry and geology. It is not unreasonable to discover or invent truths that appear to be universal and permanent. To the best of my knowledge no evidence has been turned up yet that refutes the law of gravity (at least on the surface of the earth). Even still, from time to time these very solid and highly supported truths are overturned or modified as one has to account for relativity. A second category pertains to human or behavioral sciences. This largely deals with the forces that underlie patterns of human behavior which might include historical imperatives as illuminated by Hegel or the "invisible hand" guiding economic trends. In both of these areas of study, scientists search largely for permanent and incontestable truths, but such study is generally based on samples and central tendencies that may or may not explain exceptions and outliers. The fuzziness of the boundary between

[7]This is reminiscent of the old MIS debate about the primacy of process or data in the design of systems. The argument for data is that it is relatively permanent and unchanging and, thus a more stable base for design. The argument for process is that it is relatively complex and needs concentrated attention. Ultimately whichever is primary, both need to be accounted for in their totality for systems to work with any degree of effectiveness.

the two is illustrated by areas such as biology and physiology that present a blend of findings that are relatively permanent and stable with others that are strong probabilities or are subject to an uncountable number of contingencies.

In the search for universal truths where evidence is based on probability and statistics, deviation from the central tendency and "outliers" may be dismissed as "error". If 90% of businesses consistently are shown to be motivated by profit, we have strong evidence that "businesses are motivated by profit" without necessarily considering those which are not so motivated or those who are only sometimes so motivated. But, if we posit that most people most of the time are motivated by profit, we can develop nuanced theory about the forces influencing the theory. Contingencies may moderate powerful seemingly universal forces such that new theory representations accounting for such contingencies as well as major effects represent a stronger overall collection of knowledge. The discovery of contingencies is most likely to be achieved asking why some instances do not fit within the central tendency range. Too often in both physical and especially behavioral sciences, humans are viewed as a source of error, bias, and subjectivity in a negative sense with the assumption that these need to be minimized in order to observe the lasting relationships being sought.

Simon (1996) proposed a third form of science, the science of the artificial. By sciences of the artificial we refer to the study of systems that "are synthesized (though not always or usually with full forethought) by human beings" (Simon, 1996, p. 5). Taking some liberties with a strict reading of his assertions, it is clear that humans not only do and think things, but also make things and use them to leverage our time and energy to accelerate and expand our outcomes. The things that are made may be tangible like shovels or intangible like property deeds or system development lifecycle templates. It is worth studying the things people make, why they make them, how to make them more efficiently, and what is and can be done with them once made I assert that technologies and informational structures (e.g., sets of data, information, knowledge and perhaps even wisdom) are artifacts that humans make. In a sense, it is almost absurd to think about studying humans without considering tools. How do we study the addiction of a human to computer games without considering which games, how they are played, and the technologies that enable them?

Returning to our earlier consideration of IS being largely the study of artifacts, we must note that individual studies may make the artifact and its nature the central feature of the study (e.g., what configuration of crowdsourcing applications generates the most use?) or it may be an implied background (e.g., what new constraints on leadership prerogative stem from widespread social media use). The artifact may be technical in nature (e.g., the effects of an ERP on organizational profit) or non-technical (e.g., the effects of replacing fixed with cafeteria benefits for IT workers?)

Simon (1996) argued that such systems are purposely and intentionally designed and reflect the interaction of the designers, users, and the created artifacts. From our perspective insisting that the sciences of the artificial be held to the structures and definitions of physical and behavioral science intentionally or inadvertently ignores the substantial differences between them. These differences include "meaningful totality" which is similar to emergent properties and synergies from a whole system distinct from the sum of its components' characteristics; "situational uniqueness" which refers to the tendency of traditional behavioral science to refer to aggregates but not reflect the experience of an individual facing choices or preparing for actions; and concern with urgency and uncertainty (Sandberg and Tsoukas, 2011, p. 341). Because of the continuous interplay of human purpose, the structures of the artifacts, the affordances and constraints offered by the tool itself, and the ability to select preferences and change any of these things at any time, the error, bias, choice, preference, and subjectivity of humans is itself a central and critical element in the study of the science of the artificial. The methods of physical and behavioral science which take the steps to exclude human influence, rather than include and account for it, render much of the methodology of natural and behavioral science as currently conceived inappropriate when applied to sciences of the artificial.

As a thought experiment it is interesting to consider what happens when the dependent variable that is fixed and the independent variables are subjected to influence. In other words, if we find an employee population of low ability to learn new technology, we might predict that our implementation will fail. But should a manager be satisfied with this analysis? Of course not. What if we instead said how do we achieve 100% engaged and productive interaction with the new technology? The new research question would focus on how we would accomplish this. Perhaps a set of process theories would suggest varied interventions all showing that in at least some circumstances productivity can be increased. The manager would presumably use one after the other of these processes until the objective were achieved. The role of science in such a scheme is not to offer deterministic predictions of outcomes based on antecedents but to discover and test interventions to indicate which are likely to be of benefit, how much benefit, contingencies that may affect their effectiveness, and specific variations in actions that might help customize the intervention to the case. Note that the dependent variable (the skill level of the workforce) is fixed at a particular level, which may or may not be realized while the independent variables, in the form of alternative processes, can now be applied. Through specification of the processes and measurement of the various results, a scientific process can lead to greater knowledge of the effects of each proposed process.

It might be argued that if we accept the variance and serendipity presented by humans, we cannot have science. However, this argument would assert that science as a way of thinking and approach to the accumulation of knowledge is limited to only that which is universal and permanent, thus eliminating perhaps the bulk of our experience of the world from taking advantage of its investigative power and potential. We may not yet know well HOW to shape our investigation process to accommodate the shifting sands of human participation, but pretending that we ought not or cannot address this as a straightforward, if not easy, problem is to abandon a valuable line of inquiry. Note that one obvious approach is to simply shift the infrastructure built up to study natural and behavioral sciences to the sciences of the artificial. This is not an unreasonable approach and we see the results in terms of the accumulation of knowledge to date in MIS. I assert though, that it is not enough and that we need to invent new infrastructure specifically designed to generate questions, develop methods of structuring answers, and processes for evaluation and developing confidence in our findings.

Summary

My goal was to convince you in this section that process is an integral part of the IS domain. Further to explain how, as an integral part of the domain, a body of knowledge without a heavy dose of process understanding will be incomplete at best and have little value at worst. Process knowledge is not necessarily "instead" of variance, network or other meta-theories in IS but is an important complement and component. Perhaps for a time it would be wise to bet heavily on process theory given the strong historic overvaluation of variance theory.

Advantages of a commitment to enhancing and creating process theory in IS include:

It is strongly linked to practice in focusing on what managers or other stakeholders do (or should do) to create intended results.

It raises questions about actions, interventions, and feedback loops that are not easily addressed with variance theory.

By developing a strong infrastructure for process theory, IS can make an important contribution to other fields like management, criminology, education, marketing, behavioral accounting, and the like where process is a key element and worthy of increased attention.

By adding a strong process component to consideration of attributes of states, people, and technologies, process theorizing provides a more complete ontological picture of the IS domain.

In order to further advocate for process as a key part of IS, we will turn to discussions of the nature and types of process of concern, the nature of theory in general, the way process has been and could be applied to IS domains, and a lengthy discussion of some of the barriers to producing solid process theory papers and to a field which displays this sort of knowledge prominently.

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