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Research Commentary

The Design, Use, and Consequences of Virtual Processes

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Process virtualization occurs when a process that relies upon physical interaction between people and/or objects is transitioned to a virtual environment. Process virtualization is having profound effects on society, as an increasing number of both business and nonbusiness processes such as those related to education, medicine, and dating are being migrated to virtual environments. There is a vast literature that relates to process virtualization topics, but it is fragmented across different domains. The purpose of this paper is to propose a research agenda to develop high-level theories and frameworks that inform the general process virtualization phenomenon. Developing these theories and frameworks will synthesize existing knowledge and provide a theoretical foundation upon which to add new knowledge as it is created. This will help policy makers maximize the substantial benefits of virtual processes while minimizing the risks. Given the background, interests, and skills of IS scholars, the IS discipline is well suited to lead in this endeavor.

Key words: process virtualization; virtual; physical; theory construction; electronic commerce; online dating; distance learning; telemedicine
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1. Introduction

The world is becoming an increasingly virtual place. Processes that have historically relied upon physical interaction between people and/or objects are being transitioned to virtual environments. Medical processes are being handled virtually through telemedicine, educational processes are conducted virtually via distance learning, personal shopping processes are migrating to electronic commerce websites, and interpersonal relationship processes are migrating to online social networks. We refer to this transition as *process virtualization* (Overby 2008).

For example, consider the process of dating. The inputs to the dating process are single people, and the outputs are couples (assuming the process works.) The dating process consists of a series of steps, examples of which include becoming aware of other people involved in the process, meeting them initially, assessing whether they represent a good match, and going on dates. Traditionally, the dating process has been conducted physically. Participants meet each other face-to-face at venues such as parties, bars, classrooms, churches, etc. and form their initial assessments based on these encounters. Dates are held at physical venues such as restaurants, theaters, and parks. Increasingly, much of the dating process is conducted virtually, as initial meetings and assessments (and sometimes the dates themselves) are conducted online at specialized dating sites, social networking sites, and virtual worlds.

The pace of process virtualization is accelerating as new technologies, globalization, and an "always-on" society hasten the transition to virtual environments. The central reason for this proliferation of virtual processes is improvement in the power and accessibility of information technology. Although information technology continues to enable new possibilities for migrating processes into virtual environments,

society remains firmly rooted to the physical world in many respects. For example, electronic commerce accounted for only 4% of total U.S. retail sales in the first quarter of 2010 (http://www.census.gov/retail/mrts/www/data/html/10Q1.html). Distance learning remains the exception in higher education, with most courses still delivered in the traditional, face-to-face mode (Allen and Seaman 2010). Telemedicine has been slow to replace physical doctor/patient visits (Dunbrack et al. 2010). By some accounts (e.g., see McCarthy 2010) online dating represents the single most common method by which recently married couples met, yet still accounts for fewer than 20% of couples.

These statistics illustrate that society is still at an early stage in the transition to the virtual. The research community has the opportunity to develop a deeper understanding of the process virtualization phenomenon so that as society continues to virtualize processes, this can be done in an optimal way. Research is needed to understand multiple aspects of the process virtualization phenomenon, including (a) how should virtual processes be designed, (b) how do people use virtual processes, and (c) what are the consequences of transitioning a physical process to a virtual environment. The societal implications of developing this understanding are substantial. For example, developing theories and frameworks to assess which educational, medical, and relationship development processes are best suited for virtualization—and how these virtual processes are likely to be used—will help policy makers determine how to design schools, hospitals, and parks/recreation centers in the future, thereby optimizing investment decisions on this critical yet costly infrastructure. Similarly, a deeper understanding of the consequences of process virtualization will help policy makers understand who is benefiting from virtual processes, who is harmed by them, and to what degree. This will facilitate the development of policies to ensure that potential benefits are maximized and distributed in an equitable manner and that potential harms are minimized.

To be sure, scholars in multiple disciplines have made progress on these questions. For example, medical scholars, education scholars, and sociologists have developed knowledge about the virtualization of medical processes, educational processes, and relationship processes, respectively. However, this knowledge is predominantly specific to processes within those disciplines. There is a lack of unifying theory and frameworks that span disciplines, which has created a fragmentation of knowledge about the overall process virtualization phenomenon. Constructing theories and frameworks to synthesize this knowledge will facilitate the transfer of process virtualization knowledge across disciplinary boundaries by providing a common language and by helping scholars in one discipline apply process virtualization knowledge generated by another discipline.

We submit that information systems (IS) scholars should play a leading role in developing these theories and frameworks for three reasons. First, the domain of the IS discipline is broad, as information technology increasingly affects every aspect of society. This breadth allows us to take a holistic view without being tied to a specific context. Second, such a role builds on our existing strengths. Our tradition of conducting both behavioral science and design science (e.g., Hevner et al. 2004) enables us to examine not only the behavioral implications of virtual processes but also how they should be designed and implemented. Third, we are already engaged in research on a breadth of process virtualization topics. IS scholars have studied the antecedents and consequences of the transition of multiple processes from physical to virtual environments, including medical processes (e.g., Miscione 2007), educational processes (e.g., Piccoli et al. 2001), and relationship processes (e.g., Jarvenpaa and Leidner 1999). However, we have only recently begun to use what we have learned to construct integrated theories. The purpose of this paper is to outline a research agenda to that end. We structure the research agenda around three high-level questions. First, how should virtual processes be designed? Second, how and when do people use virtual processes, particularly vis-à-vis the corresponding physical processes? Third, what are the consequences of migrating a process from a physical to a virtual environment? We believe that by addressing these questions, it will be possible to construct theory about various aspects of the overall process virtualization phenomenon that can be used to guide research and practice.

1.1. Distinguishing Business Processes from Processes in a More General Sense

It is worth noting that we have not referred to any *business* processes to this point, such as manufacturing processes, accounting processes, or fulfillment processes. This is intentional, as we use the term "process" in a broad sense to apply to processes engaged in by individuals, organizations, and society in general.[1] We use this expository device because we believe that many IS scholars implicitly equate the term "process" to "business process," effectively (but unintentionally) disallowing the use of the term in a more general sense. For example, notice that the definition of process provided by Davenport (1993, p. 5) is specific to work activities within an organization:

> In definitional terms, a process is simply a structured, measured set of activities designed to produce a specified output for a particular customer or market. It implies a strong emphasis on how work is done within an organization, in contrast to a product focus's emphasis on what.

As another example, the "process handbook" developed by Malone et al. (1999) is more precisely an "organizational process handbook."

We do not suggest that these authors have erred in their definitions. It is clear in their texts that they are referring to business and/or organizational processes and that they have simply shortened the phrase to "process" for readability. However, the unintended consequence of this is that many IS scholars have become conditioned to think about processes as being limited to business or organizational processes. This perspective is constraining, as processes—defined generally—pervade every element of society. Although we draw a clear distinction between business processes and processes in general, this does not mean that business processes are external to our discussion. On the contrary, they are quite relevant. However, our discussion is broader than business processes, and much of the research we are calling for in the future is not specific to business processes per se.

[1] We define a "process" simply as a series of steps to achieve an objective. This mirrors the general definition of process provided in the *Merriam Webster Collegiate Dictionary*, 10th edition, which is "a series of actions or operations conducing to an end."

2. Literature Summary

We divide our summary of the prior research related to the overall process virtualization phenomenon into two sections. The first section reviews the research on the migration from physical to virtual environments of nonbusiness processes, including educational processes, medical processes, and relationship development processes. The second section reviews the research on the design and management of business processes, including a discussion of how business processes differ from nonbusiness processes.

2.1. Research on Migrating Processes from Physical to Virtual Environments

Many types of processes (including but not limited to business processes) are being migrated from physical to virtual environments, including educational processes, medical processes, dating processes, and personal shopping processes. In definitional terms, *process virtualization* occurs when the physical interaction between process participants and/or objects that has traditionally characterized a process is removed. In this sense, electronic commerce represents a virtualization of the personal shopping process because the physical interaction that occurs between shoppers and products is removed. In its place, shoppers interact with representations of the products in the form of photos and descriptions. Process virtualization does not mean that all physical interaction is removed, because virtual processes tend to require that participants interact with a computer, telephone, etc. It is only the physical interaction between the participants and/or objects involved in the traditional, physically based process that is removed. It is also possible to virtualize a subset of tasks within a process instead of virtualizing the entire process. For example, although online dating sites have virtualized many of the steps in the dating process, most of the actual dates continue to occur physically. Thus, processes do not have to be purely physical or purely virtual; a hybrid or "blended" process is possible. To put it differently, whether or not a process is virtualized is a matter of degree, not of kind. Although we will sometimes juxtapose physical and virtual processes, that is for purposes of expository clarity and should not be interpreted as an assertion that hybrid forms are not possible.

There is an abundance of research on the virtualization of processes in specific domains. Below, we provide summaries of the research on the virtualization of education, medical, and dating processes. We chose these processes because they are illustrative of process virtualization topics across domains. Our review of this literature indicates that much of it can be classified into three areas: the design of virtual processes, the use of virtual processes, and the consequences of virtual processes.

2.1.1. Research on the Virtualization of Educational Processes. A substantial portion of the research on the virtualization of educational processes, often labeled "distance learning," has examined the consequences of conducting educational processes in physical versus virtual settings. For example, several studies have examined whether student achievement is higher in virtual settings versus physical settings (Bernard et al. 2004). These results are equivocal, with studies showing both higher and lower performance in the virtual setting. Moderating factors such as the nature of the subject, motivation, and background influence the relative efficacy of distance learning. Other research has focused on student satisfaction with virtual vs. physical educational settings as well as instructor satisfaction, including how distance learning affects instructor workload (Saltz et al. 2007). Although much of the research in this area has focused on the consequences of virtualizing the education process, several studies have investigated how virtual education processes should be designed (Zheng and Smaldino 2003) and when virtual and physical settings should coexist in a curriculum (Fong et al. 2008).

2.1.2. Research on the Virtualization of Medical Processes. As with the research on the virtualization of educational processes, much of the research on the virtualization of medical processes, typically labeled "telemedicine," has investigated consequences. A key question in this domain is whether telemedicine is as effective as traditional care processes in terms of patient outcomes. Meta-analyses suggest that telemedicine can yield better outcomes than physical care processes, particularly for conditions that require frequent monitoring such as diabetes, heart disease, or mental health issues (Dellifraine and Dansky 2008). Another consequence of transitioning medical processes to telemedicine is the impact on the cost of care. Research on this topic is nascent because data are poor or unavailable as well as because of a lack of agreement on how to measure costs for the different stakeholders involved in the medical care process (Bensick et al. 2006). Other studies in this domain have analyzed how telemedicine is designed and used by identifying the contexts for which it is best suited. For example, many telemedicine applications leverage the reach of technology to provide medical care to remote regions and developing countries as well as to allow physicians with specialized expertise to serve a wider range of patients (e.g., Miscione 2007).

2.1.3. Research on the Virtualization of Dating Processes. Research on the virtualization of the dating process has focused on how people use online dating websites. Because online daters do not inspect each other physically (at least not until later in the process), significant information asymmetries can develop between potential partners (Ellison et al. 2006). There is evidence that online daters exploit this to engage in deception; men often lie about their height, and women often lie about their weight (Toma et al. 2008). Other research has examined the consequences of online dating by examining how matches made online differ from matches made offline (Hitsch et al. 2010). Offline daters tend to match with partners who are similar to them in terms of income, education, and religion because they typically meet at work, school, and church. Because search costs are lower online, online daters are exposed to a wider variety of potential partners and are more likely to match based on preferences such as appearance. There is substantial research activity from firms such as Match.com and eHarmony.com regarding the design of online dating processes, including how to improve algorithms that recommend matches.

2.2. Research on Business Processes

There is a substantial body of research that examines business processes, or more generally, processes engaged in by organizational members to complete work. Researchers in multiple fields, including operations, engineering, economics, and information systems, have generated substantial knowledge in this stream. This is arguably one of the oldest research

streams in the management literature, dating back as far as Adam Smith's discussion of how the division of labor would lead to more productive and efficient business processes. Some of the first research devoted to the study of business processes was done in the early twentieth century by Frederick Taylor, who showed that work could be thought of as a process that could be decomposed, analyzed, and improved. Scholars such as Shewhart and Deming extended Taylor's work by adding statistical process control concepts, which became the foundation of total quality management (TQM) programs. Business process reengineering programs became popular in the 1990s (e.g., Hammer 1990). A key innovation of reengineering programs is that they explicitly considered the role of information technology in the design, operation, and improvement of business processes. To a large extent, it was at this point that the IS discipline began to contribute to the business process research stream (Davenport 1993) and that what we refer to as process virtualization gained prominence in the business context. More recently, initiatives such as Six Sigma have become popular, and the term "business process management" has been offered as a general label for the set of tools, methodologies, and theories designed to help firms manage and improve their business processes (e.g., Jeston and Nelis 2006). A summary of the history of this research stream is provided by Davenport (foreword to Jeston and Nelis 2006).

As the knowledge regarding business processes has accumulated, several tools, theories, and methodologies have emerged. These are well summarized in the many books devoted to business process management (e.g., Davenport 1993, El Sawy 2001, Jeston and Nelis 2006). For example, process mapping has proved useful for understanding existing processes, determining task responsibilities and interdependencies, identifying bottlenecks and inefficiencies, and designing improved processes. Process mapping has become a central tool in information systems analysis and design. Process modeling permits managers to conduct what-if analysis on the impact of changes to the process such as resequencing tasks and adding or removing resources. Software packages are available for both process mapping and what-if modeling and also permit automated processes to be generated based on the process models. Increasingly, these processes span firms as the systems allow process steps to be sourced from other parties using cloud computing and service-oriented architecture techniques. Multiple methodologies have been developed to assist firms with business process initiatives, including Six Sigma, CMMI, and SCOR. There are also standards against which the success of business process initiatives can be judged, such as the Capability Maturity Model for software development processes.

2.2.1. Distinctions Between Business and Nonbusiness Processes. Many of the tools and theories developed for business processes can be applied to processes in a more general sense. For example, process mapping and modeling tools can be applied to nonbusiness processes to document existing process flows, highlight bottlenecks, and identify potential improvements. However, there are differences between business and nonbusiness processes that prevent the direct mapping of some business process tools to non-business processes. These differences can be encapsulated into two primary distinctions: control and objectives. Because of these distinctions, research is needed to determine how much of the existing business process knowledge can be applied as is, how much will require adjustment, and how much will need to be replaced.

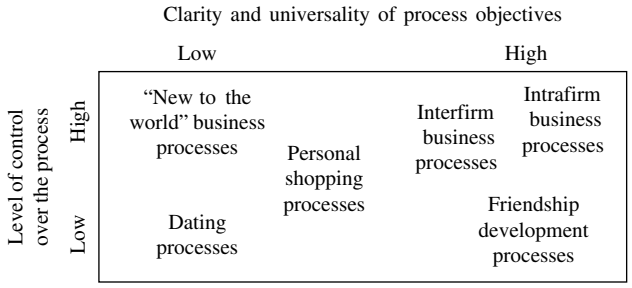
Distinction #1: Control: Control refers to the "power or authority to guide or manage" (*Merriam Webster Collegiate Dictionary*, 10th edition). Many of the tools and theories developed for business processes assume that firm management has a level of control over how processes are conducted. In fact, the motivation for most business process texts and methodologies is that business processes are assets that can be used for business advantage—if managers design and manage them properly. The assumption of control makes sense for business processes, because it is feasible for management to declare that a firm is transitioning from an old process to a new process and to implement that change (or at least attempt to). This transition requires addressing change management issues, considering potential shocks to organizational culture, developing appropriate incentive structures for employees, etc. By contrast, the assumption of control does not necessarily hold for other types of processes.

For example, there is no senior manager or other "central planner" who controls processes such as the process of dating, the process of developing friendships, or the process of learning a new concept or skill. To illustrate this distinction, consider that one of the common practices for redesigning business processes is to designate "process owners" to manage each process. Although having a process owner to oversee the procurement process is reasonable, having a process owner to oversee the dating process is nonsensical (although many a father of a teenage girl has probably tried to perform that role). As another example, tools designed to overcome cultural issues associated with business process change might require adjustment before being applied to processes that do not operate in an organizational setting. Thus, tools, frameworks, and theories constructed under the assumption of process control might require adjustment or not apply at all when the assumption of control does not hold.

Distinction #2: Objectives: By definition (either ours or any of the definitions used in the business process literature), processes are designed to achieve an objective. In business processes, the objective is typically established by management and is shared by all parties who use the process. For example, the objective of the procurement process is to purchase goods and services, and this objective is typically understood by everyone engaged in the process. By contrast, in many nonbusiness processes, there is no central planner to establish objectives, and objectives might vary by party. For example, one person's objective for the dating process might be to casually date as many people as possible, while another person's objective might be to get married. As another example, one person might engage in the personal shopping process with the objective of purchasing a good or service, while another person might engage in the same process for fun, with no intention of purchase. Thus, although the objectives of business processes are relatively focused, the objectives of nonbusiness processes might be much more diffuse. This distinction has implications for process design because knowing the objective of a process is important for designing the process.

Figure 1 provides a visual representation of how business processes differ from other types of processes.

Figure 1 Illustration of How Business Processes Differ from Other Processes in Terms of Control and Objectives



The *y*-axis depicts the level of control that management has over a process. The *x*-axis depicts the clarity and universality of the objectives of a process. Intrafirm business processes appear in the upper right corner of the matrix, with interfirm business processes such as supply chain processes closer to the center to account for potentially conflicting objectives and control struggles across firms. To capture the possibility that brand new processes implemented by firms might lack clear and universal objectives, "new to the world" business processes appear in the upper left corner. Dating processes appear in the lower left corner, as objectives vary from person to person and managers have little (but not necessarily no) control over how people engage in these processes. Personal shopping processes appear in the center because managers can exert some control over how customers shop for their products, but ultimately customers decide this for themselves. Friendship development processes appear in the lower right corner because managers have little control over these processes, but the objective of developing and maintaining friendships is generally shared by all participants.

3. Future Research Agenda

3.1. Motivation for the Research Agenda

Although a large amount of knowledge has been generated regarding the virtualization of processes in specific domains, this knowledge is fragmented. Also, it is likely that existing theories about business processes will require adjustment before they can be used to understand processes in other domains. This creates the opportunity to synthesize existing knowledge from different domains to create general theories about process virtualization. Without

these theories, there is risk that scholars in different domains will study narrow instantiations of the broader phenomenon in relative isolation, leading to a fragmentation of knowledge and potential duplication of effort. We use some of our prior research to illustrate how such a synthesis can be conducted. Specifically, the goal of a prior project (Overby 2008) was to synthesize the literature on electronic commerce, distance learning, virtual teams, and other process virtualization topics to construct a theory to explain why some processes are better suited to being conducted virtually than others. The motivation for the project was the observation that some processes (such as shopping for books) have proved more suitable for virtualization than others (such as shopping for groceries.) The resulting theory, dubbed "process virtualization theory," proposed four main factors that influence how suitable a process is to being conducted virtually: sensory requirements, relationship requirements, synchronism requirements, and identification and control requirements. The theory also discussed the role of information technology in enabling process virtualization, discussing how the increasing representation, reach, and monitoring capabilities of information technology are enabling the proliferation of virtual processes.

The method by which process virtualization theory was constructed could apply to many of the questions in the research agenda proposed below. Briefly, the method is based on Eisenhardt's methodology (1989) for developing theory based on observations from cases. The "cases" consist of detailed literature reviews on process virtualization topics from different domains. The method involves analyzing the similarities and differences across these domains, which is akin to a cross-case analysis, to generate a higher-level theory. Assessing how well the theory fits each domain permits identification of the constructs and propositions that are fundamental to explaining the phenomenon and also helps establish boundary conditions and moderating factors.

Developing process virtualization theory was one step in integrating the existing knowledge about the overall process virtualization phenomenon. Several additional steps are needed to synthesize existing knowledge and to provide a theoretical base upon which to add new knowledge. We propose the following research agenda as a method to describe these steps and how they might be achieved. We structure the research agenda as three overarching questions motivated by the three themes identified by our literature review in §2.1. First, how should virtual processes be designed? Second, how and when do people use virtual processes, particularly vis-à-vis the corresponding physical processes? Third, what are the consequences of migrating a process from a physical to a virtual environment?

To clarify the nature of our call for research, it is important to clarify what we are not calling for. We are not calling for additional domain-specific studies about the efficacy of telemedicine, or about student performance and enjoyment in distance learning environments, etc. Those studies are clearly valuable, and we would not wish to discourage them. However, we suspect that researchers are likely to investigate these worthy topics without an explicit exhortation to do so. The deeper purpose of our call is for IS scholars to generate theories, frameworks, and other knowledge that span domains. Most of the questions that we pose in the research agenda have been studied in specific domains to varying degrees, but the knowledge has not been integrated. Thus, each question should be viewed as referring to process virtualization in general, not to process virtualization in a specific domain.

3.2. How Should Virtual Processes Be Designed?

As discussed in §2.2.1, a central challenge of virtual process design is that process objectives can be variable and may not be universally shared. This represents an obstacle for virtual process designers who must either attempt to satisfy the objectives of all process participants or focus on the objectives of a subset. In addition to this consideration, there are several other virtual process design considerations that merit research. These include (a) which tasks within a process should be conducted virtually and which should be conducted physically, (b) how should the selected tasks be virtualized, and (c) who should design and implement virtual processes.

3.2.1. Which Tasks Within a Process Should Be Conducted Virtually and Which Should Be Conducted Physically? Research has shown that a blended or hybrid process design might be more

effective than a purely physical or purely virtual design (Robey et al. 2003). This means that process designers must determine which tasks to virtualize. For example, for medical processes in which telemedicine is being considered, some tasks might be good candidates for virtualization (such as an initial screening) while others might be poor candidates (such as delivering a negative diagnosis.) It might also be optimal to virtualize a process in stages, gradually adding virtual elements while potentially removing others. Field experiments and ethnography are likely to be useful methods for studying this question. Theories designed to assess the suitability of a process or task to being conducted virtually, including process virtualization theory and task-technology fit, can be applied and extended to study this question.

3.2.2. How Should the Selected Tasks Be Virtualized? By definition (see §2.1), virtualizing a task/process involves the removal of the physical interaction aspects that have traditionally characterized it. Once the physical interaction has been removed, the human actor responsible for the task can retain responsibility, or the responsibility for the task can be shifted to an information system. In the first case, the task is virtualized; in the second case, the task is virtualized and automated. For example, consider the dating process. One of the steps of the dating process is to form an initial impression of a potential partner. This can be virtualized by allowing dating process participants to form impressions based on online profiles and e-mail messages rather than face-to-face interaction. The step typically is not automated. The human actor retains control; s/he does not delegate it to an information system. However, it is conceivable that a process designer could attempt to automate this step, given enough data about preferences and software capable of interpreting profile information and handling e-mail correspondence. Research in this area is likely to draw upon design science concepts as well as computer science and machine learning theories related to collaborative filtering and artificial intelligence. Also, attempts to increase the level of automation of processes such as those related to dating, medicine, and education might strain societal norms and pose ethical issues. Many users may simply reject the option of having a computer handle certain tasks. Experimental, survey-based, and ethnographic research designs using theories such as actor-network theory are likely to be fruitful approaches to exploring these issues.

3.2.3. Who Should Design and Implement Virtual Processes? As discussed in §2.2.1, there is often no "central planner" for many types of processes. As a result, no one can dictate that a process be virtualized. The flip side of this is that anyone can attempt to virtualize a process. For example, an entrepreneur can virtualize a process, as eHarmony has for many of the steps in the dating process. In other cases, a nonprofit organization can virtualize a process, as has been the case with using telemedicine to virtualize medical care in developing countries. In other cases, a group of loosely affiliated individuals can virtualize a process, as open-source software developers have for software development. Examining which parties are best positioned to virtualize processes and how virtual process design will vary based on designer are research opportunities. Theories of entrepreneurship and user innovation can be used to study this topic.

3.3. How and Why Do People Use Virtual Processes, Particularly Vis-à-Vis the Corresponding Physical Processes?

Many virtual processes are developed as alternatives to physical processes. For example, shopping online represents an alternative to shopping in a physical store, taking courses via distance learning represents an alternative to taking courses in a classroom setting, and meeting people online represents an alternative to meeting them at parties. Thus, virtual and physical manifestations of the same process (or tasks within a process) often exist in parallel, and people can choose between them or use both. This leads to several research questions, including (a) does people's behavior in virtual processes differ from that in physical processes, and if so, how; and (b) when do people use virtual processes to substitute for physical processes (and vice versa) versus use virtual processes to supplement physical processes, and why.

3.3.1. Does a Person's Behavior in Virtual Processes Differ from That in Physical Processes, and If So, How? When a process is migrated to a virtual environment, the roles and responsibilities of the

actors involved in the process might be reallocated. For example, gender roles might shift when a dating process is migrated online, with the responsibility for different tasks shifting between men and women. The roles of supporting actors might also shift. In the physical dating process, parents and friends play a role in identifying potential matches. This role is often diminished or nonexistent in the virtual dating process (Rosenfeld 2007). Similarly, responsibility for some tasks might shift from physician to patient when medical care is transitioned to a virtual environment via telemedicine. For example, patients may become responsible for diagnostic steps, such as taking a blood sample or placing a stethoscope into position.

These changes in responsibilities lead to different behaviors that merit investigation. For example, do the behavioral changes that occur in the virtual process persist when a person shifts back to the physical process? Given evidence of deception in online dating and fraud in electronic commerce, are people more or less truthful in virtual settings, and what affects this? What role do social norms play in shaping behaviors between physical and virtual settings? Several theories can be used to inform these questions. Structuration theory and institutional theory can be used to examine how people's behavior changes when a process is migrated to a virtual environment, including how the behavior shapes, and is shaped by, societal norms and institutions. Experimental, ethnographic, and survey-based research designs are applicable research methods for this topic.

3.3.2. When Do People Use Virtual Processes to Substitute for Physical Processes (and Vice Versa) vs. the Use of Virtual Processes to Supplement Physical Processes, and Why? In some cases, a person's use of a virtual process has no effect on his/her use of the corresponding physical process. In other words, s/he uses the two as supplements. For example, some shoppers might adopt electronic commerce but continue to shop with the same frequency at physical stores. Similarly, daters might adopt online dating but continue to perform all the steps related to physical dating that they traditionally have. Other people might use the virtual process to substitute for the physical process, e.g., by abandoning physical stores (or parties) in favor of buying (dating) online. The relationship between the virtual and physical processes may also be dynamic; people might initially use the two as supplements but later use them as substitutes. Research is needed to understand the relationship between virtual and physical processes, the resulting patterns of use between the two, and why some people use the virtual and physical as supplements while others use them as substitutes. Analysis of archival data that reflects technology use might be a fruitful method to explore these questions, and theories related to technology use such as expectation disconfirmation theory, media naturalness theory, and the technology acceptance model are likely to apply. Theories from anthropology and biology such as information foraging can also help explain how people use virtual processes.

3.4. What Are the Consequences of Migrating a Process from a Physical to a Virtual Environment?

This is perhaps the most important of the three questions from a social welfare perspective. Virtual processes have the potential to improve the efficiency of our markets, to enhance the accessibility and quality of our education and medical care, and to transform our interpersonal interactions. However, the benefits associated with virtual processes might be inequitably distributed, and virtual processes might also cause harm. When considering this, it is important to recognize that consequences vary by stakeholder. For example, research in electronic commerce has shown that virtualizing market exchange processes might have positive effects for some stakeholders but negative effects for others (Kambil and van Heck 1998). Virtual processes also have the potential to disrupt industry equilibria, leading to expanded options for consumers but also driving incumbent firms out of business (e.g., consider the consequences of the changes in the process of acquiring and sharing music). Research is needed to understand whether process virtualization is "good" or "bad," for whom, and under what circumstances.

Many of the characteristics of virtual processes that yield positive consequences also generate negative ones. For example, virtual processes typically expand access. Online dating sites increase the size of the pool of potential dating partners, electronic commerce

increases the selection of available products, distance learning increases the selection of courses and degree programs, and telemedicine allows patients to receive medical care from specialists around the world. This allows access to new resources across time and space, particularly for rare or remotely located resources. Expanded access has many benefits, but there are drawbacks. Because virtual environments lack contextual and social cues that humans often use to reduce uncertainty, quality uncertainty and information asymmetry issues often arise in virtual processes. These issues are exacerbated by the expanded access afforded by virtual processes, because there are more process participants to vet. This can increase the risk of engaging with a disreputable, fraudulent, or dangerous counterparty. To be sure, information systems such as profile management and reputation systems help combat this in virtual processes, but their mere existence highlights the underlying issue. Consequences of virtual processes can be studied using transaction data as well as via experimental and survey methods. Economic theories related to adverse selection and transaction costs, particularly search costs, are relevant. Stakeholder theory and the theories related to unintended consequences also apply.

4. Conclusion

The research literature on process virtualization related topics is vast, with entire journals devoted to domain-specific topics such as distance learning and telemedicine. However, the research is fragmented across domains. Without higher-level theories that apply across domains, knowledge of the overall process virtualization phenomenon will continue to be fragmented, barriers across disciplines will persist, and research efforts are likely to be duplicated.

We believe that additional research on process virtualization topics in specific domains such as distance learning and telemedicine is needed, but calling for such research is not the goal of our paper per se. Rather, we think the time is ripe to synthesize existing knowledge across domains. We invite our colleagues to synthesize this knowledge by conducting the studies and generating the theories to inform process virtualization in a general sense. The resulting theories and frameworks will not be deterministic, and it will be impossible to apply them immutably to all processes. There will be contextual factors that moderate the proposed relationships. Despite this, the process virtualization knowledge gained in one domain can be used to inform problems in other domains, and higher-level theories and frameworks will facilitate this transfer. Not only will this synthesize existing knowledge, but it will also provide a strong theoretical base upon which new knowledge can be added.

We submit that developing these theories and frameworks will yield a fundamental contribution to social science. If recent history is any guide, we can assume society will continue to migrate processes to virtual environments. This migration can yield many benefits, but there are risks involved. Cross-disciplinary theories and frameworks will provide managers and policy makers with a broader and more accessible knowledge base to use for decision making as they are faced with the virtualization of an increasing number of processes.

Because information technology is the central ingredient in contemporary virtual processes, the IS discipline is well positioned to take a leadership role in developing these theories and frameworks. We are engaged in process virtualization topics already, we are skilled in both design science and behavioral science, and we are not tied to a specific domain, enabling us to examine the phenomenon holistically. The breadth of the IS discipline is reflected in the tagline of *Information Systems Research*, which reads, "*Information Systems Research* is a leading international journal of theory, research, and intellectual development, focused on information systems in *organizations, institutions, the economy, and society*" (emphasis added). Although we expect colleagues in other disciplines to make important contributions to the phenomenon, we believe the charter of the IS discipline uniquely positions us to deliver fundamental advancements in this area.

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