THE EMERGENCE OF SUSTAINABILITY AS THE NEW DOMINANT LOGIC: IMPLICATIONS FOR INFORMATION SYSTEMS

Completed Research Paper

Richard Thomas Watson
Department of MIS
The University of Georgia
Athens, GA 30602-6273
USA
rwatson@terry.uga.edu

Mikael Lind
Viktoria Institute
Lindholmspiren 3A
SE - 417 56 Göteborg
Sweden
mikael.lind@viktoria.se

Sandra Haraldson
Viktoria Institute
Lindholmspiren 3A
SE - 417 56 Göteborg
Sweden
sandra.haraldson@viktoria.se

Abstract

A dominant logic describes the manner in which a firm or society organizes much of its activity in order to be successful. Historical analysis indicates that the information systems developed during a period reflect the needs of the current dominant logic of that era. It is argued that the current customer service dominant logic is being replaced or complemented by a sustainability dominant logic, which reflects the growing concern with environmental issues. The implications for IS scholarship and education are discussed. In particular, there will likely be a greater emphasis on optimization and simulation techniques and more attention to managing large data sets in research and teaching. In addition, there is a need to revisit socio-technical frameworks that ignore the environment as a key factor in IS design and deployment decisions.
Keywords: Dominant logic, sustainability, socio-technical systems, flow analytics, sensors
A society in transition

Societies and civilizations move through periods dominated by a specific logic for success (Watson, Howells, et al., 2011). A particular core competency is preeminent and is the main driver of a society’s economic success, and becomes the major means of achieving status and the acquisition of wealth within that society. The economy for a specific phase is structured around a particular question that is addressed by the preeminent logic of that era. Admittedly, there might be short-term periods when a particular problem (e.g., war) changes the focus, but we take a long-term perspective that can span millennia. Furthermore, each phase is also supported by a set of information systems that enhances successful execution of the dominant logic. These core ideas are expressed in Table 1.

Table 1: Dominant logics (Watson, Howells, et al., 2011)

<table>
<thead>
<tr>
<th>Economy</th>
<th>Subsistence</th>
<th>Agricultural</th>
<th>Industrial</th>
<th>Service</th>
<th>Sustainability</th>
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<tbody>
<tr>
<td>Question</td>
<td>How to survive?</td>
<td>How to farm?</td>
<td>How to manage resources?</td>
<td>How to create customers?</td>
<td>How to reduce environmental impact?</td>
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<td>Dominant issue</td>
<td>Survival</td>
<td>Production</td>
<td>Customer service</td>
<td></td>
<td>Environmental sustainability</td>
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<td>Key information systems</td>
<td>Gesture</td>
<td>Mathematics</td>
<td>Accounting</td>
<td>CRM</td>
<td>Simulation</td>
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<td></td>
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An enterprise’s dominant logic determines how it organizes itself to solve the problem that it sees as most important to its success and survival (Vargo & Lusch, 2004). Core competency, with its focus on the “bundles of skills and technologies” that a firm uses to create a value proposition (Prahalad & Hamel, 1990), is a complementary concept because it focuses on what an organization has to do well to thrive. As the IS alignment literature stresses, the role of IS is to support an enterprise’s strategic direction (Chan et al., 1997; Henderson & Venkatraman, 1999), which is fundamentally determined by its dominant logic. A firm that settles on customer service as its dominant logic must then develop a strategy to deliver that service. For example, it might settle on an online delivery model (e.g., Amazon) or in store service (e.g., Macy’s) and then develop a set of skills and technologies that enables execution of its customer service strategy. Many organizations can have the same dominant logic, but there are wide variations in strategies based on that logic. The role of IS is to support execution of the chosen strategy.

While the concept of dominant logic is rooted in how an enterprise organizes itself, in a particular phase of economic development many firms will have adopted the same dominant logic, as implied by Vargo and Lusch (2004) in their analysis of a societal transition from a production to customer service dominant logic. Thus, a dominant logic tends to be paramount in an economic age. For example, during the U.S. agricultural period, the bulk of the population was employed in farming. At the time of U.S. independence in 1776, 90 percent of the labor force was agricultural, and by 1997 it was three percent (Johnson, 1997). Over 200 years later in the early days of the 21st century, 55 percent of the U.S working age population is in the service sector (Schettkat & Yocarini, 2006).

The UN environment program promotes the sustainability dominant logic of a green economy as a new engine of growth (United Nations Environment Programme, 2011). Thus, a transition to a sustainability dominant logic is likely to witness a restructuring of sectorial employment, albeit over a long term. This prospective shift in dominant logic has important implications for IS because such a move will result in a
new set of organizational strategies and a concomitant challenge to IS units to create a new class of systems to support execution of those strategies, as this article’s analysis of past eras illustrates.

This work’s prime research method is historical analysis, a social science technique for establishing a platform for understanding contemporary or emergent issues (Gardner, 2006). While not a common approach in IS research, it parallels the perspective that a literature review is an analysis of the past to prepare for the future (Webster & Watson, 2002). Some historians would argue that an analysis of critical prior events is foundational to studying the present and the near future. We use historical analysis for identifying important questions that we think should engage IS scholars interested in Green IS.

This article is structured as follows. It first reviews existing literature to present the history of human life as a series of successive dominant logics. It then discusses the emerging dominant logic of sustainability, and considers the interplay between dominant logics as enterprises organize around one dominant logic while cognizant of the need to attend to the dominant logics of a prior era. The flow concept is used as a means of understanding how enterprises might structure themselves in a sustainability dominant logic era. Finally, some implications for information systems research and education are discussed.

### Subsistence societies and a survival dominant logic

Prior to 11,000 BCE, all societies were hunter-gatherers (Diamond, 1997, p. 16). It was the only logic of that epoch. Even as recently as 1500 CE, hunters occupied one third of the earth. Pre-agrarian people led a subsistence life style. Their daily decision-making was generally dominated by finding enough food to survive. They subsisted by hunting wild animals, fishing, and collecting wild food plants. Except for dogs, there was no domestication of animals or plants (Lee & Daly, 1999).

Some bands of 15-50 people, the main form of organization during the period, were more fortunate than others in their ecological endowment and had to spend less time finding food than others (Diamond, 1997, p. 60). Survival was very dependent on what could be found locally and how long it took to accumulate sufficient food to survive and reproduce. Gesturing and speech were the information systems of this economy. Human communication originated as gestures, pointing, and pantomiming (Tomasello, 2008, p. 11). Mastering of gesturing, and later language, likely increased the survival prospects of early humans because it enabled them to collaborate. Cooperative information exchange enabled our ancestors to coordinate their actions when hunting, building housing, and fighting, for instance. The goal was to survive, and those of our forebears who learned how to use gesturing and speech to coordinate their actions were more likely to survive and reproduce. Some tribes developed specialized information exchange systems that suited their environment. For example, the Pirahã of the Amazon communicate by whistling when hunting (Colapinto, 2007), clearly a superior means of information exchange than gesturing or speaking when seeking prey in a dense forest. Rudimentary information systems, such as an extended set of words for counting, are not found in some indigenous languages. Some Australian Aboriginal languages only have words for one, two, and many (Harris, 1990). Presumably, counting confers little advantage in a subsistence economy. When subsistence dominated logic prevailed, the information systems that emerged, gesturing and speech, enhanced cooperation and enabled groups of humans to successfully hunt, forage, and defend themselves.

### Agricultural societies and a food production dominant logic

Agriculture emerged between 5,000 to 10,000 years ago in several regions of the globe (Weisdorf, 2005). The shift from foraging to farming, the Neolithic Revolution, initiated the rise of civilization and enabled some societal members to spend time on non-food producing activities (Diamond, 1997). From this group emerged people devoted to management, religion, engineering, science, and the creation and transmission of knowledge. In an agrarian society, while not everyone is involved in agriculture, it is dependent on reliable and plentiful food production. Thus, in agrarian systems, the dominant logic is centered on how to farm and husband animals. This logic of success creates a need for several information systems. Farmers need to keep track of how many animals they have (counting) and also determine the value of an exchange (multiplication). Division becomes necessary when wealth needs to be shared, such as an inheritance among children. These were not issues for the preceding subsistence society because its members acquired little during a lifetime. Furthermore, once humans started creating structures beyond rudimentary dwellings, there was a need for geometry to design buildings.
An economic system emerges once a society starts to generate a surplus (e.g., grains and goats), and this creates a need for recording and processing transactions. Hence, writing appears first in the form of clay tokens and then later as cuneiforms around 3200 BCE (Schmandt-Besserat, 1992). This evolution from clay tokens to a writing system took hundreds of years or possibly longer (Diamond, 1997, p. 224). As economic systems grew, their leaders introduced taxes to fund public buildings, defense, and other activities. Taxation requires record keeping and accelerated the development of mathematics and writing. Building the Egyptian pyramids required many slaves and bureaucrats (Richards, 1999, p. 153), and thus record keeping methods. It appears that writing is not critical for an agricultural society, as the Incas ran an empire without it (Diamond, 1997, p. 215), but they did use knots on string for recording decimal numbers (Ascher & Ascher, 1997).

In addition, cultivators had to know when to plant their crops. By studying the movement of the moon, sun, and planets, early astronomers learned how to create the first calendars and provide guidance on when to plant crops. By 900 to 800 BCE, Babylonian astronomers were recording their observations on clay tablets (Richards, 1999, p. 146). Predicting the arrival of the annual flooding of the Nile was important to Egyptian agricultural production, and thus it was an impetus to Egypt's development of astronomy and a calendar. One estimate is that such calendars were developed around 3500 BCE (Richards, 1999, p. 153).

For thousands of years, society was dominated by agriculture and it was the main method of wealth creation. During this period, writing, mathematics, and calendars were developed to serve the information retrieval, information processing, and record keeping needs of an agrarian society.

**Industrial society and a goods production dominant logic**

The industrial revolution began in earnest in the 1760s in western Europe and the U.S., extended to Russia, Japan, other parts of Europe, Australia, and Canada in the 1880s onwards, and more recently extended to China, India, Brazil, and Turkey (Stearns, 2007). The industrial revolution combined new sources of energy, specialization, and coordination, and a scaling of human organization to increase the mass production of goods. Production is the dominant issue for an industrial society, and it is very focused on how it can manage resources, particularly humans, to maximize output. Thus, in current times there is controversy about workers' conditions in mass-scale Chinese factories striving to achieve high levels of productivity (Hille, 2012).

While most industrial revolution scholars portray it as a transformation in technology and organization, there was also a revolution in information systems, albeit at a slower pace. The new industrialists needed to count and measure at a level well beyond that required to support agriculture. They had an order of magnitude, or more, of resources to manage and coordinate. An information system was required to record and report resources and their conversion into revenue. The need for a highly detailed and well-established method of counting that extended well beyond the recording systems that served agriculture and trading, gave rise to cost accounting as a derivative of the older financial accounting. As early as 1690, decades before the full tempo of the industrial revolution, there is evidence of iron works using cost accounting to calculate input-output yields for raw materials (Edwards et al., 1995). While, financial accounting first emerged in Europe in its double entry form in Italy in the 14th century (Heeffer, 2009), it is not until 1854 that it became professionally organized with the granting of a Royal Charter to create the Edinburgh Society of Accountants (Perks, 1993).

The industrial revolution also generated other types of information systems. The origins of operations research, applying the scientific method to business problems and decision-making, can be traced to the early years of the 20th century (McCloskey, 1987) and latter emerged as management science. As the scale of industrial activities rose, there was a need for a method to more effectively managing a multitude of tasks. In the late 1950s, Critical Path Method (CPM) and Project Evaluation Review Technique (PERT), which were independently developed, appeared as systems for systematically processing the data related to a large project to reduce project duration and resource requirements (Stretton, 2007).

Ideas of using mechanical approaches to processing information emerged in the late 17th century (Larsen, 1986). Perhaps the most successful of these mechanical systems was Hollerith's mechanical card sorter, which was introduced in 1886 (Kistermann, 1991). Significantly for IS scholars, in 1951 the LEO I (Lyons Electronic Office I) was the first electronics-based business computer (Bird, 1994) and the forerunner of
information systems in business. It is this association with computers that dominates current thinking about information systems, and many see the two as inseparable leading to the common misunderstanding that IS and IT are synonyms, whereas an IS is a combination of people, procedures, and IT (Piccoli, 2008). It is possible to have an information system without a computer. Early record keeping systems were information systems, and in our broad view, language and writing are information systems that helped humans to process information for tens of thousands of years before computers.

In summary, the industrial revolution created a mass scale need for elaborate information systems to run the many enterprises that emerged. Prior to the industrial revolution, organizations were typically small except for a few large enterprises, such as the government, major churches, and some trading companies. Mass scale creates new problems and is attractive to innovators because of the large number of potential customers seeking solutions to information management and analysis problems, such as cost accounting systems.

**A consumer society and a customer service dominant logic**

The shift to a customer-service dominant logic is chronicled by Vargo and Lusch (2004), who describe how marketing shifted from the exchange of tangible goods (production focus) to the exchange of intangibles, such as specialized knowledge, skills, and processes that change to the state of the customer or some object they possess (e.g., cosmetic surgery or financial investment). They argue for a paradigm shift from a production perspective of the industrial era to a customer orientation. Because they broadly define services as “the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself,” they argue that a service-dominant logic applies to both products and services. A computer, for example, is a device for delivering information services, and specialized skills are required to enact the service potential of a computer.

A customer-service dominant logic firm is continually striving to create greater value for its customers than its competitors (Vargo & Lusch, 2004). We see this continually played out in the market for many information services. Apple, for instance, uses the iTunes platform to create a value proposition that makes its physical products, such as the iPhone, more valuable to customers. Similarly, Amazon is trying to position the Kindle as a device for seamlessly delivering books to its customers. Both firms have built core competencies, “bundles of skills and technologies” (Hamel & Prahalad, 1996) that can deliver to their customers a higher value proposition than their competitors.

As you would expect, information systems have a key role in executing a customer service dominant logic. They are part of the bundles of skills and technologies that can create a core competency. It is important to recognize that rarely is information technology a source of competitive advantage because there is an open market for information technology. Everyone can essentially buy the same hardware and software. It is the bundles of skills that a company can apply to convert an information technology into an information system that creates a competitive edge. UPS has a highly developed global logistics system for parcel delivery, not because it uses a certain brand of hardware or software, but because it has applied a high level of skill to designing, building, and implementing information systems.

Customer relationship management (CRM) emerged as a new class of information systems to support the shift in dominant logic in the mid 1980s. The first *Harvard Business Review* article on CRM (Jackson, 1985) appeared in 1985. An early book (Turnbull, 1986) on the topic was published in 1986. However, we don’t see much in the IS literature until some years later. The first identifiable article in the AIS Electronic Library was published in 1999 (Plattner, 1999). Business analytics is a more recent development than CRM, and its importance is highlighted by the publication of an influential book in 2007 (Davenport & Harris, 2007). It is not surprising that business analytics followed CRM, because once the notion of CRM was accepted, firms then started to look at how they could determine which customers they should service and how they should be served.

Over the last decade or so, developments in classes of information systems, such as CRM and business analytics, and extensions of industrial era systems, such as ERP, reflect the shift to a customer dominant logic. These new systems are designed to help a firm execute its dominant logic by managing relationships with customers, discovering what customers value, and determining the value of customers.
A sustainable society requires a new dominant logic

Sustainability was initially viewed by many companies as reducing the risks of law suits and cleanup costs from environmental damage, cost reduction by reducing waste, and designing products with minimal toxic components and maximal recycling potential. Such reactive strategies put management on the back foot and foster a siege mentality (Shelton, 1995). An alternative perspective is that sustainability becomes a strategy rather than an operational tactic (Hart, 1997) and companies can move from being constrained by regulations to controlling their future (Shelton, 1995). As a result, the shift to a dominant logic of sustainability offers the prospect of many new profitable products and services. In particular, a sustainability strategy can lead to the high returns often derived from technological innovation. While industry peers are still competing on the basis of the prior dominant logic, early shifters have a chance to create breakthroughs that invalidate the value of older competencies. Similarly, while emerging economies are often centered on a production dominant logic (e.g., China in manufacturing and Brazil in agriculture), the advanced economies can create the technology that companies in developing economies will need when environmental degradation, population growth, and resource depletion become so critical that they will also need to adopt a sustainability dominant logic.

Some scholars foresaw the emergence of a new dominant logic to address environmental sustainability, the critical long-term issue facing the globe. As early as the late 1970s, sociologists (Catton & Dunlap, 1978) identified a need for a paradigm shift to emphasize environmental issues. Management scholars (Gladwin et al., 1995) picked up the theme in the mid 1990s. Now there are signs of the emergence of the practice of this new dominant logic in advanced (Laszlo & Zhexembayeva, 2011) and emerging economies (Schumpeter, 2011). The current focus on creating and serving customers is layered on top of the preceding dominant logics, production and survival. It will in turn be overlaid by the need to reduce environmental impact because of the accumulated effect of humans on air and water quality, biodiversity, ocean acidity, and other environmentally damaging outcomes.

A dominant logic of sustainability means that organizations forefront the question “How do we reduce our environment impact?” and organize to address this question. This is an emerging issue for several reasons. First, more forward looking executives see both a threat and an opportunity arising as they scan the information horizon and detect signals indicating that environmental changes threaten their existing modus operandi. They recognize that starting to solve these issues now will strategically position them for the longer-term as governments and consumers take action to mitigate environmental degradation. Some of the signals are quite alarming and should spur action. For example, one estimate suggests that covering the full environmental cost of their production would cost firms 41 percent of their earnings on average (KPMG International, 2012). Such coverage of full environmental costs is being advocated (Watson et al., 2012) because the current economic system is not working in the interests of sustainability (Grunert & Thøgersen, 2005). Markets could work to advance sustainability if prices reflected full environmental costs (Stern, 2007), but at present many of these costs are externalized as poor air quality, polluted streams, and deforestation. Facing such evidence, it is not surprising that some firms recognize the need for a shift in their driving logic. Indeed, a shift to a sustainability dominant logic can drive innovation and growth (KPMG International, 2011) leading to higher returns (Carbon Disclosure Project, 2011).

Logic multiplicity

The multiple players in an economy are often at different stages of their business development. Some might be struggling for profitability, and survival dominates their thinking. Others might have a central focus on operational efficiency because they compete in a market with low margins. As a result, they organize around the management of resources to ensure high productivity. Another group of companies, typically those that are customer facing, emphasize service. Finally, we expect a fourth, and at this stage minor, group who pay attention to their environmental impact. In addition, a firm’s adoption of a higher layer in the dominant logic hierarchy does not mean it can neglect the lower layers. The ecologically motivated firm still needs to serve customers well, manage resources efficiently, and create sufficient profits to remain a thriving concern. There is a multiplicity of logics it must serve, but one has to dominate and be the central focus of its decision-making and strategy. For example, Apple is typical of the companies facing this challenge. Its emphasis on the customer experience clearly spearheads a customer dominant logic, but it is mindful of the need for production efficiency, addressed by outsourcing to a
production dominant logic firm, and is being forced by governments and Greenpeace to heed environmental consequences (Bradshaw, 2012).

Sustainability logic puts considerable emphasis on the efficient use of non-renewal natural resources because it recognizes their finite nature. Thus, its emphasis on minimizing waste and energy efficiency is highly compatible with many aspects of a production dominant logic. Sustainability differs from production dominant logic in that it embraces minimization of environmental impact into a central concern for highly efficient and sustainable use of finite resources. The smokestacks of the industrial era externalized environmental issues as smog and acid rain. Thus, we think many organizations will be able to reconcile the differences between production and sustainability dominant logics by focusing on efficient use of finite resources, especially if governments use regulations and taxes to internalize costs that are currently externalized to society (Watson et al., 2012). Customer dominant logic will be more challenging to reconcile.

Given the current dominance of customer service, we foresee firms trying to balance dual dominant logics as the transition to a sustainable society occurs. Sustainability is emerging as a co-existing dominant logic for those organizations that recognize current practices cannot continue or for those that face externally imposed edicts that necessitate becoming more sustainable. While sustainability covers a breadth of issues, such as cradle-to-cradle design and recycling, most of the current emphasis is on CO\textsubscript{2} emission reduction because this is the most pressing environmental problem. Consequently, we focus on the flows that consume energy and typically produce CO\textsubscript{2} emissions. We live in an economy dominated by flows that distribute (e.g., an electricity grid) or consume energy (e.g., road and air traffic flows) (Watson, Boudreau, & Chen, 2010). Seeking sustainability means that society has to make such flows more energy efficient and less carbon emitting. Ideally, all flows are powered by non-polluting renewable energy sources. A flow changes the location of an object (e.g., transporting a person by air from Stockholm to Atlanta or moving a container from Shanghai to Rotterdam). Flows are an essential element of most service systems because movement is often a key component of a service. Moreover, flows are typically central to value creation. Transporting a passenger to her destination is the value proposition of an airline, and it competes with other transport companies to create a more enticing value bundle.

The presence of these dual dominant logics means that firms must try to balance the competing demands of customer service and sustainability. This potential conflict can be handled by recognizing that service delivery is a set of processes (Hammer & Champy, 1993) and sustainability requires minimizing the energy consumed by flows (Watson, Boudreau, & Chen, 2010) (see Error! Reference source not found.). A process changes the state of an object, often a customer. Booking a ticket is a procedure that changes the state of the customer to a traveler to destination on particular date and flight. Moving that traveler and her luggage is an example of a flow. By logically separating processes and flows (even though they are often physically intertwined), we open up ways of thinking about innovations in each area, both separately (e.g., improving the quality of a service or by reducing the energy consumed by one type of flow) and jointly (executing services during a particular flow). For example, more flyers might be willing to take a train to the airport if they could do check-in and security on the train trip. Organizations can create value through the efficacy of their processes (e.g., streamlining check-in to reduce wait time) and flows (e.g., prompt collection of baggage at a destination). Given the importance of flows, we need to examine them more carefully.
Perspectives on flows

The central premise of this article is that a firm's dominant logic determines its information systems needs, and in the preceding section we have pointed out the centrality of flows to sustainability. Two streams of research, constructal law (Bejan & Zane, 2012) and energy informatics (Watson, Boudreau, & Chen, 2010), are both built around the study of flows. Constructal law takes a broad brush view to understanding design and proposes that society is a flow system (Bejan & Zane, 2012) governed by the constructal law, which states that, “For a finite size flow system to persist in time (to survive) its configuration must evolve in such a way that it provides easier and easier access to the currents that flow through it.” It is argued that a wide variety of flows, both created naturally and by humans, follows the constructal law. Independently, the energy informatics framework, which is presented as a tool for creating efficient and sustainable production and consumption systems, proposes that society is a network of energy flows.

These two perspectives coalesce around the notion of design. Constructal theory is about explaining observable natural designs. Flows create shape and structure (e.g., a river delta, blood flow in lungs, a tree). Energy informatics is about the design of energy efficient flows. In terms of constructal thinking, we propose that to create an energy efficient physical system, the designer must identify what will flow through the system and then create a shape and structure, perhaps taking a cue from natural flows, that facilities efficient flow. In addition, the designer needs to identify what information flows will enable those who use the physical system to make choices that minimize their energy use, and thus the energy use of the entire system.

The two approaches differ with respect to time. The constructal law is extracted from long-term phenomena such as the creation of a river system or the evolution of an organ, whereas energy informatics is concerned with both static design, such as a road system, and dynamic design, such as altering a road system’s signals, to eke out energy savings on the macro and micro levels. As a result, information systems can be used to collect and analyze information, and disseminate it to control system objects to vary flows dynamically. It can also distribute information to consumers to influence the use of a physical flow system.

Implications for information systems

It is helpful to have a macro framework as a foundation for the identification of IS implications. We view the world as based on three major elements, society, technology, and the environment, both natural and built (Figure 2), which is consistent with prior work on the linkage between IS and sustainability (Elliot, 2011). In brief, we live in societies that make extensive use of technology to change the natural environment and create a built environment. While subsistence societies had minimal technology and a minor built environment, they did influence the natural environment (e.g., the destruction of the Australian megafauna with the arrival of the Aboriginals (Bowman, 1998).

Much of the IS and management literature ignores the natural environment, and focuses on the relationship between the social and technical elements. Thus, once we add the environment to the world view equation, we need to revisit many foundational concepts, such as the socio-technical system (STS) framework (Bostrom & Heinen, 1977a, 1977b). As already argued, we also need to recognize that the energy consuming flows that occur in natural and built environments are the source of many ecological issues. In order to understand these flow systems, we need technology to amass data (sensor networks), and these data can be used to both optimize flow systems and inform humans about how they might change their behavior to reduce their environmental impact.

Consequently, in order to conjecture on the implications for IS, we first think about IS in the larger
context by applying the STS model, which has implicitly influenced the field for decades. Second, we look at flow systems, which have been presented as the central concern for Green IS. We then follow on to look at the consequences of an emphasis on flow systems in terms of the data they generate, the types of settings in which they are embedded, and how they impact human behavior, because ultimately we will need to change our ways to create a sustainable society.

**Reassessing the socio-technical model**

The STS model embraces two ideas, social and technical systems, which have remained at the center of IS research for decades. IS scholars primarily study the interaction between the social and technical systems (Benbasat & Zmud, 2003). However, STS lacks a natural systems component, and it ignores the effect of a technical system on the environment, but technical systems (e.g., transport and the built environment) are responsible for much ecological degradation. Increasingly, managers will need to consider the intersection of the social, technical, and environmental systems when making decisions. Flows of material and energy in technical systems affect the environment (Bengtsson et al., 1998). Thus, we need to extend the established STS model to incorporate environmental systems. One possible adaptation is to focus on the inherent types of change represented by the original STS model and made explicit in Figure 3.

There are three orders of change, alpha, beta, and gamma. Alpha change occurs when technology is used to change a task, beta when technology changes a person’s role and tasks, and gamma when there are changes in technology, task, people’s roles, and organizational structure. These same sorts of changes typically also perturb the environment, but this impact is usually ignored when the dominant logic is not centered on sustainability. Rather than trying to add the natural system as a third dimension and another set of interactions to the existing model, we might first attend to the interaction between the type of change and the natural system.

*Eco-efficiency,* “the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth’s carrying capacity,” (DeSimone et al., 1997) could be mapped to alpha change. UPS’s use of telematics to reduce truck idling is a good example of alpha change that seeks eco-efficiency (Watson, Boudreau, Li, et al., 2010). *Eco-effectiveness* (McDonough & Braungart, 1998), which pays regard to doing the right thing such as making green products and delivering green services, fits with gamma change. Interfaces’ reorganization from selling to leasing carpet exemplifies the eco-effectiveness of gamma change (Anderson, 1998). The appointment of a Chief Sustainability Officer (CSO), a beta change, is an early sign of the inclusion of sustainability in the dominant logic. Such an appointment could ultimately lead to gamma change if the CSO can initiate structural change. Thus, an interesting opportunity for IS scholars is to learn what information the CSO role requires and how it is used.

We challenge IS scholars to take the STS framework and reinvent it to fit IS scholarship in the era of sustainability dominant logic. STS is a change model, and deleterious environmental change is the core driver of the dominant logic shift. As a result, we have to create a new class of information systems that reverse ecological degradation by improving eco-efficiency and eco-effectiveness. These new information systems will be designed to improve the health of the environment, and we need a revision of STS to incorporate consideration of natural systems to guide development of new Information Systems.

**Flow network analytics**

Flow analytics is a possible parallel to business analytics of the customer service dominance mindset.
There will be a need for software systems, and corresponding human skills, that result in the dynamic optimization of flow networks by a variety of approaches, such as adjusting demand to match supply as in the electricity industry or curtailing demand to match capacity as in a traffic congestion management system. INRIX (Applegate & Johnson, 2012) provides an early indication of the sort of software that will support flow network analytics. By crowd sourcing traffic data, INRIX collects data that it can feed into traffic prediction algorithms to predict traffic flows across road systems. Its European and U.S. customers include automakers, logistics fleets, public administrations, radio stations, websites, and mobile app providers.

The Energy Informatics framework (Watson, Boudreau, & Chen, 2010), which lays out the relationship between information systems, sensor networks, flow networks, and sensitized objects, provides directions for future research through a series of eight research questions. Many of these directly apply to flow network analytics (e.g., What information is required to optimize a given type of flow network?) and provide a foundation for IS scholarship in this area.

IS scholars could become involved in developing flow analytics as a discipline by transferring knowledge gained from the use of business analytics to address customer dominance thinking. They could also apply lessons gained from studying other types of information systems to increase the success rate of the design and deployment of flow analytics applications.

**Big data from vast sensor networks**

Flow analytics will rely on multiple real-time digital data streams to identify the current state of a system and make decisions on how to move it to a less environmentally damaging condition. For example, Singapore has a sensor network to continually monitor traffic flow and uses the real-time data to predict congestion and then manipulates traffic lights to avoid traffic jams (Fischetti, 2010). The sensor networks necessary for managing flow networks will generate massive data flows that will typically require real-time processing and action. While big data has become a catchy phrase to describe issues related to handling massive streams of real time data, the current discussion mainly focuses on the flow of consumer-generated data emanating from web applications (e.g., Facebook and online sales). We suspect that this might look like a rivulet compared to when sensor networks come online in scale. Data generated by sensor networks and machines is likely to become massive because of the sheer number of sensors that will be embedded in the environment and the frequency with which they can report. In China, for example, Guangdong province has installed over one million cameras and the city of Chongqing is planning half a million installs (Economist, 2012). Danish Wind Power company Vestas expects to require 6 PB of storage to manage sensor data from more than 43,000 wind turbines (Zikopoulos et al., 2012, p. 32).

Initially sensor networks might be measuring items such as temperature and air quality, but it is conceivable that digital imaging will replace single measure sensors. A digital infrared image, for example, could dynamically report the thermal image for a building and enable detection of open windows and other phenomenon that reduce energy efficiency. A picture can potentially measure many variables across the angle of its lens. A digital image might well be worth more than a thousand sensors, because every pixel is a piece of information.

Big data tools, such as Hadoop, have become available to handle data tsunamis. IS scholars will need to study such tools and associated ancillaries (e.g., see Hortonworks’ data platform) and understand the impact they have on decision-making related to sustainability issues. This knowledge should then be applied to improving the quality of such decision activities. We see an iterative loop between sensor network design and decision quality. Initially, sensor networks will provide base data for measuring an environmental state and support sustainability decision-making, and as managers learn more about how they can advance sustainability, they will request different environmental measures at differing frequencies. IS scholars, given their position on the pathway between information technology and decision-making, need to become part of this iterative process so they help to improve decision-making through the design of better data capture, processing, and delivery systems.

1 http://hortonworks.com/technology/hortonworksdataplatform/
**Symbiotic physical and informational modeling and simulation**

Flow networks and their associated sensor networks are the technical side of society. Societies, however, exist within the natural and built environment, such as rivers, mountains, cities, highways, and buildings. The physical systems of the built environment consume energy (e.g., buildings) and determine how we consume energy (e.g., road systems). They are the sources and sinks of flow systems (e.g., the daily commute) or the home of a flow system (e.g., a building’s HVAC system), and as such they will be major data flow generators and will present opportunities for energy optimization. As well as improving the performance of these physical systems, we can wrap information systems around them to promote desirable changes in human behavior (Watson, Boudreau, et al., 2011). For example, IS scholars could examine how information systems can increase the utilization of public transport options, because of the societal energy savings and CO2 emission reduction.

The complexity of these physical systems means there will be a need for IS scholars who can work with engineers using languages such as Modelica (Mattsson et al., 1998), to model complex physical systems and to simulate the symbiotic relationship between physical and informational systems. For example, one of the authors is working with engineers to model a chiller system on a university campus. We will augment this dynamic model with information about room usage from the university’s master calendar and temperature forecasts. The goal is to minimize the cost of electricity by taking into account the needs of a room’s occupants and electricity spot pricing (on a hot summer’s day peak pricing can be several multiples of standard pricing). In another case, we are working with an airport authority to develop innovations in information availability about transport options to and from the airport and novel ways of delivering such information to reduce the airport’s ecosystem’s carbon footprint.

IS scholars have generally paid little attention to the physical systems of our world. This has been left to engineers, but we have information management and analysis skills they lack, and they have engineering knowledge in which we are highly deficient. With the advent of service dominant logic, some IS scholars formed partnerships to advance knowledge of the application of CRM and business analytics. The arrival of a new dominant logic predicates the formation of a partnership between engineering and IS scholars to make our physical systems more sustainable. Jointly, through modeling and simulation, we can create a new class of information systems that aims to optimize from an ecological perspective our built environment.

**The impact of information on consumer environmental behavior**

Many people seek a sustainable lifestyle, yet it is often difficult for them to achieve this goal because they lack information about the environmental consequences of their choices. Information is critical to consumer decision-making irrespective of the product or service being considered for consumption. It is, however, particularly critical for a world seeking sustainability because the future environment is a product of individual consumption decisions today. Citizens need to be aware of the environmental responsibility of the brands and firms they favor and the ecological impact of the products they purchase (Watson et al., 2012). An information system is the bedrock of such awareness. Society needs to have in place mandatory standards for measuring and reporting an organization’s sustainability record. We require financial reports for investors in public companies, and we should require sustainability reporting for the public because we are all invested in the future of the earth. Similarly, required food and drug labeling should be extended to incorporate sustainability information for all products and service. We need information systems that will enable people to make informed decisions about the environmental consequences of their consumption patterns.

IS scholars are perhaps most able to handle currently the relationship between information and consumer environmental behavior, because we have established streams of research on the design of information systems and human information processing. We need to focus this prior knowledge on the new domain of environmental behavior. We should also be able to contribute to policy related to the design of a public reporting system for organizations, products, and services. AIS might opt to take a role in assisting legislators to frame laws and regulations that will result in information systems that increase the effectiveness of environmentally related decision-making. Alternatively, as individuals we can seek to offer our expertise on this matter.
Implications for education

The introduction of business analytics has seen a renewal of the teaching of statistics and its applications to business problems. For years, every business school student has studied statistics, but the problem domain was usually seen and presented as limited to operational problems (e.g., whether an additive changes a car’s gasoline consumption (Verzani, 2005, p. 226)). Business analytics has pushed statistics into the strategic arena. Now firms can use their vast data stores to decide which customers they want to pursue, predicting the value of a new customer, and evaluating experimental manipulations of a web site that might serve millions of customers per day.

We foresee a similar revival in management science and simulation, topics that have shrunk or disappeared from management education in the last few decades. Flow network analytics will require knowledge of techniques such as linear programming and its extensions (Elwes, 2012), the traveling salesman and knapsack packing problems, which were integral to many management science courses. Simulation will come to the fore for handling complex flow problems not amenable to mathematical solution, and systems dynamics (Forrester, 1961) will be valuable for illustrating the non-linear nature of environmental systems and the many interdependencies in a flow system.

Big data is likely to enter the curriculum as part of the introductory data management course found in most IS majors, but IS professors need to ensure that they place it in the context of handling large volumes of both customer-generated and sensor-generated data. Examples from both domains should be deployed, and ideally there should be open access to a real-time sensor network that students can use for manipulating and analyzing real-time data.

University administrators often express a strong desire for interdisciplinary courses, and we need to press them to enable us to deliver courses that unite engineering and IS students in the common pursuit of solving sustainability related problems. Physical and information systems need to be co-designed and co-managed to deliver higher levels of energy efficiency and utilization. The data exchange standards and information processing elements of physical systems should be a forethought rather than an afterthought. For example, a major car manufacturer has realized that it is doubling the number of software engineers it hires every seven years because it developed a proprietary software platform. It realizes this is an untenable future and is now looking to establish a consortium of car manufacturers to create cross-platform standards. Physical systems need to upgrade their energy and social intelligence. There is a need for physical systems that have high levels of energy efficiency and greater ability, through modularity and data exchange standards, to ‘play well with others.’ We will need to educate a new generation of IS majors who are comfortable contributing the information component of engineering solutions. We've supported their education in business subjects such as finance and marketing, and now we need to extend our horizons to embrace engineering.

Conclusion

We provide one perspective for thinking about the consequences of a new dominant logic, we readily acknowledge that there are potentially other viewpoints, and we present a starting point that we can be elaborated, extended, and potentially discarded as practice advances and theoretical insights become clearer. As any new era emerges, it is difficult to conjecture its consequences and, in our case, its information systems implications. What is important, however, is that the potential change is recognized and a discussion of its repercussions initiated in scholarly circles.

IS scholars and practitioners have lived in exciting times for some decades, and we have become accustomed to change and need to get ready for another metamorphing wave. The transition to a sustainable dominant logic represents a major transformation for society and the role of IS. Many of us will need to shift our attention to confront society’s environmental problems because business leaders are realizing that sustainability is their problem, and they need to rethink the core competencies and directions of their organizations. For thousands of years, IS has been a faithful servant of the dominant logic. Information systems have emerged to enable a society to organize successfully around a chosen

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2 Personal conversation with the former CEO of a major automotive software firm.
dominant logic. We will need to once again demonstrate our creativity and innovation in research, practice, and education to serve a new master, sustainability dominant logic.

References


http://www.unep.org/greeneconomy/greeneconomyreport/tabid/29846/default.aspx