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ORIGINAL ARTICLE

The service system is the basic abstraction of service science

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Abstract Abstraction is a powerful thing. During the nineteenth century, the Industrial Revolution was built on many powerful abstractions, such as mass, energy, work, and power. During the twentieth century, the information revolution was built on many powerful abstractions, such as binary digit or bit, binary coding, and algorithmic complexity. Here, we propose an abstraction for the twenty-first century, in which there is an emerging revolution in thinking about business and economics based on a *service-dominant logic*. The worldview of service-dominant logic stands in sharp contrast to the worldview of the goods-dominant logic of the past, as it holds service—the application of competences for benefit of others—rather than goods to be the fundamental basis of economic exchange. Within this new worldview, we suggest the basic abstraction is the *service system*, a configuration of people, technologies, and other resources that interact with other service systems to create mutual value. Many systems can be viewed as service systems, including families, cities, and companies, among many others. In this paper, we show how the service-system abstraction can be used to understand how value is co-created, in the process laying the foundation for an integrated science of service.

Keywords Service science · Service-dominant logic · Service system

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1 Introduction

In the context of a shared worldview, abstractions help scientists see unity in diversity and measure the world. Abstractions allow seemingly different things to be compared, and allow one phenomenon to be explained in terms of another better understood or simpler phenomenon. Consider gravity. This abstraction can be used to understand both a falling apple on Earth and the motion of the Moon, planets, stars, and galaxies. Given this abstraction, we can measure the mass of objects and the forces two masses exert on each other. The right abstraction provides language that helps people communicate, reason, and take action. During the nineteenth century, the Industrial Revolution was built on many powerful abstractions of the physical world: mass, energy, work, and power, to name just a few that proved valuable. Whether work was done by simple machines, compound machines, steam energy, chemical energy, or electromagnetic forces, the abstraction "work" could encompass and unify all of that great variety and variability, enabling engineers to measure forces and calculate work needed to accomplish all sorts of physical jobs. During the twentieth century, the information revolution was built on many mathematical abstractions: binary digit or bit, binary coding, and algorithmic complexity, to name a few. Of course, the abstractions are not the phenomena, but they create language that enables people to communicate and create shared worldviews. With binary codes we can talk about the amount of information in a book, song, or movie, and engineers can use these measurements to design better cellphones, MP3 players, and digital televisions.

In this paper, we are concerned (1) with the nature of "service"—generally speaking, business arrangements in which one party does something for another and that has benefit for both; and (2) with the abstractions needed to understand and improve service—that is, the scientific understanding, management principles, and engineering discipline needed for effective service innovation (Spohrer and Maglio 2008). Specifically, we suggest that there is an emerging revolution in business and economic thinking for the twenty-first century based on a new worldview, *service-dominant logic* (S-D logic), and on a new basic abstraction, *service system*. More precisely, we define "service" as the application of resources for the benefit of another (Vargo and Lusch 2006). Many activities can count as service, including automobile repair, hair styling, information technology (IT) outsourcing, manufacturing, and business consulting. Informally, service systems are dynamic configurations of resources that can create value with other service systems through shared information (Spohrer et al. 2007). Many sorts of things can be viewed as service systems; for example, people, corporations, foundations, non-governmental organizations, non-profits, government agencies, departments in an organization, cities, nations, and even families can reasonably be viewed as service systems, or dynamic configurations of resources. A key behavior is that service systems interact to co-create value. For example, viewed as service systems, a package delivery company transports objects from other companies or individuals; value is co-created in that results depend on both transportation contributed by the delivery service and objects and locations contributed by the clients.

Our main argument is that understanding service and service innovation requires new ways of thinking (worldviews or logics) and new abstractions—and specifically, developing a new science of service means developing a new basic unit of analysis of service, the service system. In what follows, we describe the service-system abstraction in some detail. We first introduce the notion of "service" as traditionally used by economists, and then challenge the traditional view by introducing S-D logic as a new paradigm for thinking about resources, exchange, and human action. S-D logic motivates the need for the service-system abstraction. We next explore service systems in more depth, and offer the beginnings of a more formal view of the structure and composition of service systems, including the connection to general systems theory. We conclude with challenges and future opportunities for research.

2 Ways of thinking about service and the economy

Measuring economic activity is complicated. Economists focus on mechanisms that allow a system of monetary exchange to work (efficiently) to establish what will be paid for output (Williamson 1985). Since Adam Smith, most economic analyses have depended on abstractions such as ownership, production, and goods. Because Smith aimed to understand how to increase the wealth of a nation (specifically, England) during the industrial revolution—as manufacturing was becoming systematized by increased scientific understanding of physics and mechanical systems—he focused on the production of goods (Smith 1776/1907). Smith called labor (i.e., service) that resulted in physical goods "productive labor," and he called labor that did not result in physical goods "unproductive labor." In the economic science that followed, this productive and unproductive distinction morphed into "goods" and "services," with the latter defined residually as any economic activity that is not manufacturing or agriculture. Thus, in this traditional economics worldview, the lines between sectors were clearly drawn.

In the mid-1950s and 1960s, the part of the economy that could not be classified as manufacturing or agriculture—usually referred to as the "service sector"—grew larger than the manufacturing sector in number of jobs (Clark 1957), and economists and politicians sought to understand how economic growth worked in the service sector. Baumol developed a model aimed at understanding the relationship between productivity growth and wages in productive sectors (manufacturing) and "asymptotically static" sectors (such as the service sector) (Baumol 2002). The economy was said to suffer from Baumol's disease as the size of the service sector grew, and the overall prospects for economic productivity growth seemed low.

As recently as the late 1980s, non-manufacturing growth was still widely perceived as a drag on the overall economy (Cohen and Zysman 1988). But all that began to change with increased deployment of information and communication technology (ICT). Productivity in retail (bar code scanning, megastores, e-commerce) as well as financial and communication services (computers, electronic trading, fax machines, pagers, cellphones, internet) surged throughout the 1990s (Gadrey and Gallouj 2002). In 2002, even Baumol produced a sophisticated model that showed research and development (R&D) service activities to be the queen of the service sector (Baumol 2002). As long as R&D service productivity increased, even "asymptotically static" sectors might enjoy continuous productivity growth—and even surges—as new technologies and system interaction factors took hold.

Today, the apparent growth of what is traditionally called the "service sector" is reflected in the gross domestic product (GDP) statistics of nations. As currently measured, developed countries have 70–80% of their GDP and employment in the service sector (government, healthcare, education, retail, financial, business and professional, communications, transportation, utilities), with 15–25% in the manufacturing sector, and about 5% in the agricultural sector (Tien and Berg 2006). The service sectors of both India and China are growing rapidly. India is known for information technology (IT) service outsourcing. Reflecting the new positive view of service growth in an economy, China's 2006–2011 5 year plan specifically called out the goal of "Transitioning to Modern Services."

Yet despite apparent significant growth associated with the service sector (as measured by traditional economics in accord with the standard economics worldview), there is no widely accepted, non-residual definition of service among economists—that is, except as whatever is left over after manufacturing and agriculture (Chesbrough and Spohrer 2006), and measurement of service productivity, quality, regulatory compliance, and innovation are all still problematic (Chesbrough and Spohrer 2006). In our view, the abstractions needed to understand service and service innovation have not been clearly articulated. Perhaps the difficulties in agreeing on a definition and on measurement approaches to service result from a fundamental problem: The worldview of economics is wrong.

The traditional economics worldview—what we will call goods-dominant logic (G-D logic)[1] (Lusch and Vargo 2006; Vargo and Lusch 2004)—is centered on the good, or more generally, the "product," including both tangible (goods) and intangible ("services") units of output. Others have referred to goods-dominant logic as the "neoclassical economics research tradition" (Hunt 2000), "manufacturing logic" (Normann 2001), and "old enterprise logic" (Zuboff and Maxmin 2002).

From the G-D perspective, "services" (plural) are seen either (1) as a restricted type of goods (i.e., as intangible units of output), or (2) as add-ons that enhance the value of a good. G-D logic implies that principles developed to manage goods production can be used to manage services "production" and "delivery," assuming that they are adjusted for the differences between goods and services. This is the logic most frequently used in discussions of transitioning from goods to service.

By contrast, in S-D logic, service is defined as the application of competences (knowledge and skills) for the benefit of another party (Vargo and Lusch 2006). The use of the singular "service" as opposed to the plural "services," represents a shift from thinking about value in terms of *operand resources*—usually tangible, static

[1] The term "logic," as used here, is intended to mean mindset or worldview rather than a formalized structure.

resources that require some action to make them valuable—to *operant resources*—usually intangible, dynamic resources that are capable of creating value. That is, whereas G-D logic sees services as (somewhat inferior to goods) units of output, S-D logic sees service as the process of doing something for and with another party. Value creation, then, moves from the firm, or “producer,” to a collaborative process. In S-D logic, value is always co-created.

The purpose of economic exchange in S-D logic is service provision for (and in conjunction with) another party to obtain reciprocal service—that is, *service is exchanged for service*. Whereas goods are sometimes involved in this process, they are appliances for service provision; they are conveyors of competences. In either case—service provided directly or through a good—it is the knowledge and skills (competences) of the providers and beneficiaries that represent the essential source of value creation, not the goods themselves, which are only sometimes used to convey them.

Importantly, S-D logic represents a shift in logic of exchange, not just a shift in type of product that is under investigation. It is a shift that Vargo and Lusch (2004) insist is already taking place. They point out that evidence of this “new logic” can be found in somewhat diverse academic fields such as information technology (e.g., service-oriented, architecture), human resources (e.g., organizations as learning systems), marketing (e.g., service and relationship marketing, network theory), the theory of the firm (e.g., resource-based theories), etc., as well as in practice.

Rather than implying that goods-based models of exchange should be modified to transition to a service orientation, S-D logic suggests that a service-based foundation, built upon service-driven principles, is a generalizable worldview for understanding all economic activity (i.e., even when goods are involved) and thus a more robust logic for transitioning from goods to service. S-D logic is a mindset, a lens; the tasks of building an S-D logic-based theory and science remain. One of the first associated tasks is elimination of the “producer” versus “consumer” distinction (see Vargo 2008). In a value-cocreation and service-for-service conceptualization of exchange, the notion of one party being the creator of value and the other being a destroyer makes no sense. Thus, a different, more generic conceptualization of the parties is required. We call these entities “service systems.”

3 A new unit of analysis: the service system abstraction

From S-D logic, service is the application of competence for the benefit of another. So service involves at least two entities, one applying competence and another integrating the applied competences with other resources (value-cocreation) and determining benefit. We call these interacting entities *service systems*. More precisely, we define a service system as a dynamic value-cocreation configuration of resources, including people, organizations, shared information (language, laws, measures, methods), and technology, all connected internally and externally to other service systems by value propositions (Spohrer et al. 2007). People are physical resources with legal rights, organizations (such as businesses) are conceptual resources with legal rights, shared information is a conceptual resource treated as property, and technology is a physical resource that is treated as property. Every service system has a unique identity, and is an instance of a type or class of service systems (e.g., people, businesses, government agencies, etc.). The history of a service system is a sequence of interaction episodes with other service systems.

Imagine a population of service systems interacting to co-create value (e.g., all the people, businesses, and government agencies in a city interacting on a single day). Value-cocreation interactions between service systems are *service interactions*. Each service system engages in three main activities that make up a service interaction: (1) proposing a value-cocreation interaction to another service system (proposal), (2) agreeing to a proposal (agreement), and (3) realizing the proposal (realization). A proposal might be for a single well-defined value-cocreation interaction (e.g., notarizing a document), or for an ongoing series of interactions not completely defined (e.g., signing an employment agreement). Agreements can either be formal, codified in an explicit or tacit legal contract (e.g., corporate onboarding), or informal (e.g., nodding to the next person in line to have a document notarized), in which case dispute resolution may become an open issue to be negotiated. Two special types of proposals are (1) to co-create a new *instance* of a service system, or (2) to co-create a new *type* of service system. For example, opening a new business, or establishing a new hybrid public–private agency that establishes a barter currency to promote volunteerism in the community. Proposals can either be agreed-to or rejected. Agreed-to proposals either can be successfully realized to the mutual satisfaction of both service systems, or can fail to realize the hoped-for potential, as expected and determined by one or both service systems. For example, in the case of the new barter currency, counterfeiters may take advantage of modern copying technology and disrupt the hoped-for rise in volunteerism in the city. The resolution of failures may be handled formally or informally.

Service systems have a beginning, a history, and an end. Formal service systems have a set of legal rights and responsibilities associated with them during their histories (e.g., businesses and their employees must file annual tax returns), whereas informal service systems may not (e.g., whose turn is it to do a household chore within a family). Culture provides tacit guidance about rights and responsibilities, and the legal system over time may formalize portions of this tacit knowledge. Although a service system judging the value co-created from its frame of reference is a complex activity based on tangible, intangible, objective and subjective measures, this is precisely what service systems do all of the time—determine what value is being co-created with other service systems and adjusting accordingly.

Not all service system interactions qualify as service interactions. Figure 1 sketches our Interact-Serve-Propose-Agree-Realize (ISPAR) model of service systems interaction episodes. An interaction episode is a series of activities jointly undertaken by two service systems. Broadly speaking, interactions can be service interactions (interactions that aim to co-create value) or non-service interactions. For an interaction to be a service interaction, a proposal must be made by one party to another, agreement must be reached between the parties, and value must be realized by both. If value is not realized, there may be a dispute, which in turn may or may not be resolved to the satisfaction of both parties. If an interaction is not a service interaction, it may be welcome or unwelcome, and some unwelcome interactions may be illegal interactions. ISPAR is a normative model that aims to cover the space of possible interactions between systems with a total of ten different outcomes.

For instance, consider IT outsourcing as an example of service interaction (S). Suppose an IT service provider proposes to take over the web hosting for a retailer doing business on the web so the retailer can focus on its core business—selling its goods—rather than on running its systems. The value proposition might be that the provider can use its expertise to deliver IT services more effectively and more cheaply than the retailer can itself. In large outsourcing deals, the proposal process is very formal and results from months of work by teams on both the provider and client sides (P). Of course, there may be cases in which the proposal does not effectively communicate the value proposition to the client, as when the provider does not use the business language of the client (−P). In any event, given a proposal, provider and retailer must come to an agreement about what IT systems are to be to run, what kinds of performance are to be measured, and what price is to be paid (A). The parties may not reach an agreement (outcome −A) in every case, for instance if the client does not want to pay the price set by the provider, or the provider cannot agree to the performance metrics required by the client. Over time, the retailer may realize the proposed value (systems running effectively as agreed, R), or it may not realize the value (systems not running as agreed, −R). The goal of

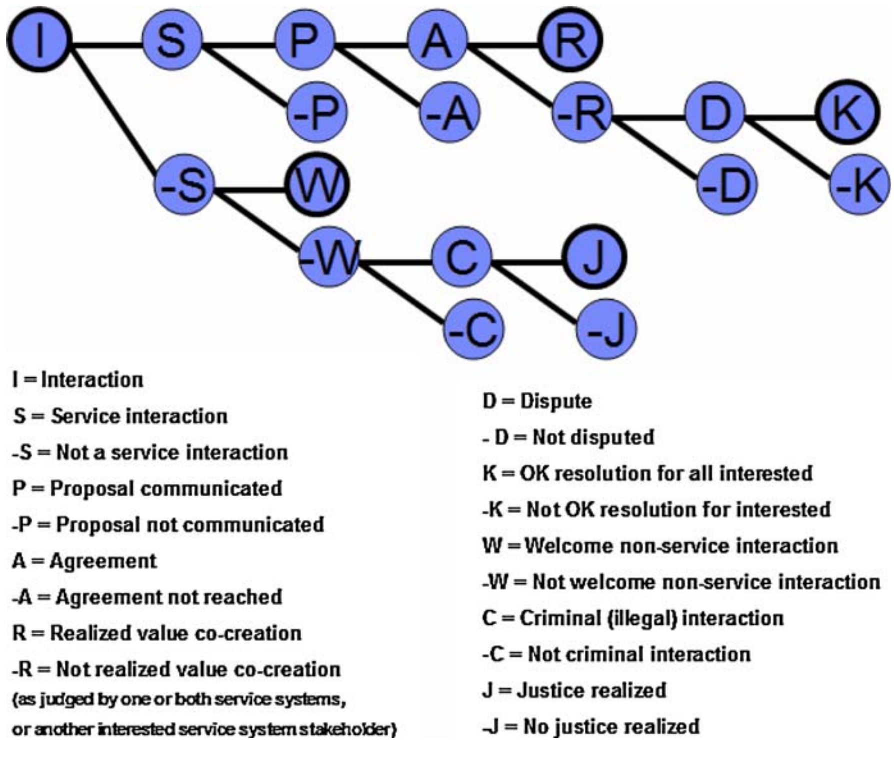

Fig. 1 ISPAR model of service system interactions

course is to realize value on all sides, a win-win outcome. If the value is not realized, the retailer may bring the problems to the provider's attention (D), and work together with the provider to resolve the problems. In the end, any problems may (K) or may not (−K) be resolved satisfactorily for both parties, and for any additional stakeholders (such as suppliers or governments). Disputes may arise from the provider side as well. The IT service provider might not be able to deliver on the agreed-to services at the agreed-to price if the retailer underestimated the number of servers or other aspects of the size of the job. In this case, the provider may bring the problems to the attention of the client (D), and they can work together to solve them (e.g., renegotiate the contract taking a more realistic size into account, K). If a private resolution cannot be found, a law suit, and external governance mechanisms may be invoked to resolve the dispute (Tapscott 2003).

Now, consider non-service interactions in which two service systems do not co-create value effectively. All kinds of casual interactions between people or between organizations are non-service interactions, including informal conversations or inquiries. Often, these are welcome interactions (W), as when one walks into a store to ask about the price of an item displayed in the window—the both the customer and store owner welcome the opportunity to discuss the item, as it may lead to future business. Even if this is not a win–win interaction, it is at least neutral, and may set up potential for the future. Sometimes interactions between systems are not welcome (−W), as when one firm attempts a hostile takeover of another. In this case, the target firm might not welcome the interaction if the bidder is offering too little or has intentions to change the mission or composition of the target firm. At least one of the parties sees itself losing as the result of the interaction. Some unwelcome interactions may actually be criminal interactions (C) in which one of the parties stands to lose substantially because the other does not play by commonly accepted rules of behavior (such as laws). For example, the company attempting a hostile takeover may have illegally learned secret financial information about the target firm that it can then use to its advantage in negotiations (−J). If the target firm of the governing authority discovers this illegal activity, it can take the firm to court to see justice done (J).

The ISPAR model enables us to see the world as populations of interacting service systems of different types (people, businesses, government agencies, etc.). A great variety of entities can be unified by a single abstraction, and a great number of measurements can be developed. For example, the life span of a service can be measured in terms of the number of interactions and types of outcomes with other service systems, rather than simply in terms of chronological time. The distribution of outcomes over time becomes an interesting signature in comparing service systems. Any pair of service systems has a history of interactions as well as a distribution of outcomes, and all the pairs of instances can be compared to look for patterns. Though the stability of a population of service systems might be measured as an increasing trend in the proportion of (R) outcomes to other types of outcomes, it may also indicate that a population of service systems is losing innovativeness. The quality of a service system might be measured as the trend in the ratio of (R) to all other outcomes combined.

Fully mapping the types of service systems that exist, the range of service interaction episodes during their life cycles, the way value-cocreation is determined, and the way disputes are resolved are just some of the key problems in service science. Disputes and how effectively they are resolved is an important mechanism for learning and improvement of service systems. Disputes arise from hazards, and some are well studied by economists, such as bounded rationality and opportunism. For instance, Williamson (1999) describes two types of economic institutions, environmental institutions that define the rules of the game, and governance institutions that are required to play by the rules of the game while dealing with the dual hazards of bounded rationality and opportunism in people. Economic institutions are service systems, and unifying the ISPAR model with transaction cost economics is an area for future research.

4 Foundations of service systems

We now turn to a more formal description of the structure and composition service systems. First, some basic definitions:

- A system is a configuration of resources, including at least one operant resource, in which the properties and behavior of the configuration is more than the properties and behavior of the individual resources.
- Operant resources can act on other resources (including other operant resources) to create change.
- Service is the application of resources (including competences, skills, and knowledge) to make changes that have value for another (system).
- Value is improvement in a system, as determined by the system or by the system's ability to adapt to an environment.
- Economic exchange is the voluntary, reciprocal use of resources for mutual value creation by two or more interacting systems.

Given these, we formally define a service system as an open system (1) capable of improving the state of another system through sharing or applying its resources (i.e., the other system determines and agrees that the interaction has value), and (2) capable of improving its own state by acquiring external resources (i.e., the system itself sees value in its interaction with other systems). Service systems are dynamic configurations of resources, both operant resources that perform actions on other resources and operand resources that are operated on (Vargo and Lusch 2004). In this context, economic exchange depends on voluntary, reciprocal value creation between service systems (each system must willingly interact, and both systems must be improved).

General systems theory provides a framework for understanding complex relations in configurations of operant and operand resources (von Bertalanffy 1976). But service systems are not defined by the relations and interaction of resources alone. Some operant resource must act, at the very least providing the proposal, agreement, and determination of value-cocreation. Service system boundaries are defined by the resources that operant resources can bring to bear. And underlying value-cocreation does not depend on service system structure. The car wash and the car will create a clean car under normal circumstances. The proposal, agreement, and determination of value associated with the commitment of the owner of the car and the owner of the car wash define the service system interaction.

A service system is a configuration of resources, and so it is also a resource itself. In fact, a service system may be a resource acted upon by another service system. We can define an atomic service system as one that uses no other service systems as resources. An individual person is an atomic service system. We might measure the size of a service system in terms of the number of atomic service systems (or the number of people) involved in it. In any event, within the class of atomic service systems, we can distinguish between service systems with only one resource and service systems with multiple resources. A carpenter is an atomic service system, as is a carpenter with a toolkit, truck, and stock of building materials.

Atomic service systems and other resources can be combined to form composite service systems. Possible composite structures include hierarchies and market-based structures. In a hierarchical arrangement, the identity of the constituent service systems may be irrelevant (e.g., one who has arranged for house-building services through a general contractor may not need to know details of the constituent contractors—these are hidden effectively). In a market-based arrangement, participating service systems must retain their own identities (e.g., one requiring house-building services may contract with carpenters, plumbers, and masons directly).

Intermediate arrangements and structures can also be defined. The ability to pool resources across a set of combined service systems is a particularly interesting case. A cooperative of carpenters, masons, plumbers, and roofers might agree to share their tools while building a house, resulting in value-cocreation at the level of the constituent systems within the larger house-building service system. Alternatively, each may strictly guard his or her own tools, leading to little internal value-cocreation.

Not all compositions of service systems are themselves service systems. The collection of contractors, for example may behave simply as a building resource. It requires the operant general contractor to make the proposal, agreement, and determination of value. The general contractor function may be a separate service system or may operate as a committee of contractors—but without such an operant resource, there is no service system.

Service systems are dynamic: composing, recomposing, and decomposing over time. Service systems that persist in substantially the same form over long periods are open systems through which operand resources flow, but in which operant resources are stable. For example, in a manufacturing plant, new materials (operand resources) are assembled by the same workers (operant resources) each day. A service system may redistribute its resources over time. For example, the contractors sharing tools may be advantageous for the overall service system. But incorporating a new contractor onto the construction crew is a qualitatively different sort of change in that it involves merging previously independent service system into the larger one. In the end, there may be many mechanisms of combination and adaptation for service systems.

In sum, general systems theory provides a foundation for thinking about the formal structure of service systems. We have explored only some of the implications, considering (1) how operant and operand resources can be arranged within and across systems for effective value-cocreation, (2) the nature of atomic service systems, and (3) methods and mechanisms of service system change. A general systems theory orientation toward service systems implies service systems are evolutionary, complex adaptive systems with emergent properties (e.g., value creation).

5 Conclusion

Challenges and opportunities for service science abound (Maglio et al. 2006; Spohrer and Maglio 2008). Chief among the challenges that lay ahead is the challenge of developing a shared vocabulary that can be used across disciplines to describe the great variety of service systems. Here, we have only begun to enumerate some of the abstractions needed for service science. In fact, given our service system abstraction and the service-dominant logic worldview on which it depends, we can define service science and its variations:

- Service science is the study of the application of the resources of one or more systems for the benefit of another system in economic exchange.
- Normative service science is the study of how one system can and should apply its resources for the mutual benefit of another system and of the system itself.
- Service science, management, and engineering (SSME) is the application of normative service science.

The service-system abstraction is under development. Can it unify a great deal of variety? Can it, along with the ISPAR framework, provide insights into new and important measures of the world? We believe that viewing the world of people, businesses, and governments as a population of interacting service systems can lead to improvements in service quality, productivity, regulatory compliance, and sustainable innovation.

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