The Service System Is the Basic Abstraction of Service Science

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Abstract

Abstraction is a powerful thing. During the 19th century, the industrial revolution was built on many powerful abstractions, such as mass, energy, work, and power. During the 20th 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 that will be important to the service revolution of the 21st century: the service system, which is 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 created, in the process unifying concepts from many disciplines and creating the foundation for an integrated science of service.

1. Introduction

Abstractions help scientists to see unity in diversity and to measure the world. 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. Here we are concerned with the nature of "service" – generally speaking, business arrangements in which one party does something for another and that has benefit – and with the abstractions needed to understand and improve service – that is, the scientific understanding, management principles, and engineering discipline needed for effective service innovation [17].

During the 19th 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. For example, 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. And engineers using early steam engines to pump water from coal mines could measure the work performed in units related to the time taken to move a mass of water acted on by the force of gravity a certain height (W = FD = mgD = m(d/t2)d = m(d/t)2 = mv2).

During the 20th century, the information revolution was built on many mathematical abstractions: binary digit or bit, binary coding, and algorithmic complexity, to name a few. The abstraction "binary coding" can unify great variety and variability of everyday phenomena. The abstraction is not the phenomena. 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 propose an abstraction for the service revolution of the 21st century: the service system. We define "service" as the application of resources for the benefit of another [23]. Many activities can count as service, including automobile repair, hair styling, information technology (IT) outsourcing, and business consulting. Informally, service systems are collections of resources that can create value with other service systems through shared information [18]. 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. A key condition 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 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. We then challenge the traditional view by introducing Service-Dominant Logic (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 then evaluate the utility of the service-system abstraction in its ability to unify concepts from multiple disciplines. And we conclude with challenges and future opportunities for research.

2. Old Service Economies

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 [27]. 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 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 [15]. Smith called labor that resulted in physical goods "productive labor," and he called labor that did not result in physical goods (i.e., service) "unproductive labor." For economic purposes, service was thus defined as whatever economic activity is not manufacturing and agriculture.

In the mid-1950's and 1960's, the part of the economy that could not be classified as manufacturing – usually referred to as the "service sector" – grew larger than the manufacturing sector in number of jobs [5], 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) [2]. The economy was said to suffer from Baumol's Disease as this service sector grew, and the overall prospects for economic productivity growth seemed low.

As recently as the late 1980's, non-manufacturing growth was still widely perceived as a drag on the overall economy [6]. But all that began to change with increased deployment of information and communication technology (ICT). Productivity in retail (bar code scanning, megastores, e-commerce) and financial services (computers, electronic trading, fax machines, pagers, cellphones) surged throughout the 1990's [7]. In 2002, even Baumol produced a sophisticated model that showed research and development (R&D) services to be the queen of the service sector [2]. 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 the service economy is reflected both in the gross domestic product (GDP) statistics of nations, as well as the annual reports of manufacturing companies that show growing service revenue. 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 [20]. 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 Five Year Plan specifically called out the goal of "Transition to Modern Services."

Yet despite apparent significant growth associated with the "service economy" as measured by traditional economics, there is no widely accepted definition of service among economists – except as whatever is left over after manufacturing and agriculture [4]. And measurement of service productivity, quality, regulatory compliance, and innovation are all still problematic [4]. In our view, the abstractions needed to understand service and service innovation have not been clearly articulated. One issue has been that goods are associated with technology, which can do physical work or information work, and that services are associated with human labor, which can also do physical work or information work. Porat measured the information-work economy separate from the physical-work economy [13]. Solow measured the labor (people), capital (technology), and innovation (improvement in people's skills and in technology's capabilities, as well as organizational innovations and other factors) as separate components of the economy [16]. These attempts at measurement look for a few key types of resources that matter to economic growth, much like Smith. But perhaps the difficulties in agreeing on a definition and on measurement approaches to service are the result of an even more fundamental problem: Perhaps the basic logic of economics needs to be rethought.

3. New Service-Dominant Logic

Over the last 20 or 30 years, there have been numerous initiatives for transforming firms, if not whole industries, from a goods orientation to a service orientation [24]. These initiatives have generally been motivated by perceptions of the general transformation in developed countries from industrial economies to service economies, as noted. Given this justification, the approach has typically been to identify the differences between goods and services and then to adjust innovation, production, and market strategies to accommodate these differences.

Though both the specific cause and the approach are appealing, they do not fully capture the underlying issue and the need for a more fundamental transformation in the logic1 of economic activity and in the understanding of the role of the firm.

Goods-Dominant (G-D) Logic [9, 22] is centered on the good – or more generally, the "product," including both tangible (goods) and intangible (services) units of output – as the focus of exchange. The essence of G-D logic is (see [22]): [1]

1. Economic exchange is fundamentally concerned with units of output (products).

2. Products are embedded with value during the manufacturing (or agricultural, or extraction) process.

3. For efficiency, production ideally (a) is standardized, (b) takes place in isolation from the customer, (c) can be inventoried to even out production cycles in the face of irregular demand.
4. Products can be sold in the market by creating demand.

In short, the purpose of the firm is to make and sell things. Others have referred to this good-centered logic as the "neoclassical economics research tradition" [8], "manufacturing logic" [12], and "old enterprise logic" [29].

As previously suggested, the roots of G-D logic are found in economic science and date back to the work of Smith (1776). Though often referred to as "the father of economics," Smith did not literally invent economics, nor was that even his purpose. Smith was a moral philosopher and his focus was more of a normative concern for what was right and good for society and what nations should do to enhance national wealth than it was a positive concern for how economic activity functioned.

Smith initially derived his political-economic views from the foundational proposition of the efficiency of the "division of labor," resulting in the necessity of "exchange." For Smith, labor was the "fund which originally supplies (the nation) with all the necessities and conveniences of life which it annually consumes" [15, p. 1]. Thus labor, the application of mental and physical skills – that is (essentially) service (see [22]) – provided the foundation for exchange.

However, after establishing labor/service as central to exchange and well-being and the central metric of exchange as value-in-use – benefit in relation to the labor required to achieve it – he partially abandoned this model. Smith was not inherently concerned with all of exchange or with economic exchange in general. As noted, he was seeking a normative explanation about which types of service should be promoted in order to advance national wealth. He thus, shifted the focus to value-in-exchange (nominal value, market price), rather than value-in-use, which he felt was easier to understand and also simplified his task of the identification of activities that contributed to the creation of national wealth.

In Smith's 18th Century world, with limitations on personal travel and the non-existence of electronic communication, the primary route to wealth creation was the export of tangible goods and the source of these goods was manufacturing [15]. Thus, his underlying model was centered on the product – surplus tangible goods that could be exported. This narrowed focus on the exchange value of tangible goods can be seen in his extended discussion of the distinction between "productive" and "unproductive' activities (see [26]). For Smith, only those activities that contributed to the creation of surplus tangible goods were "productive." Other activities, though useful and essential to individual wellbeing, were

[1] The term "logic," as used here, is intended to convey a mindset, or generalized approach to understanding, rather than a formalized structure.

"unproductive" because they did not create exportable, tangible goods.

Other economic philosophers (e.g., [11, 14]) who followed typically disagreed with Smith's productive versus unproductive distinction, reasoning that all activities that contributed to wellbeing were productive; but, having done so, they also typically acquiesced. Smith's [15] productive/unproductive distinction had taken root by then and, over time, "products" (tangible goods that could be exported) became the focus of economics; value morphed from usefulness to an embedded property of goods (essentially value-in-exchange); "unproductive" morphed into "services" (intangible goods); and a clear distinction between producers (creators of value) and consumers (destroyers of value) was established.

This product- or goods-based model of economic activity was convenient for another reason; it was compatible with the increasing desire of the economists who followed to turn economic philosophy into economic science. The model of "science" at that time was Newtonian Mechanics, a model of matter embedded with properties. Thus, an economic model of products embedded with utility had natural compatibility and appeal. Therefore, at least partly because of the desire for scientific respectability, the goods centered paradigm survived and flourished. Economics and the derivative business disciplines, as well as more general, societal understanding of commerce, emerged and developed from this G-D paradigm.

From this G-D perspective, services (plural) are seen as either (1) a restricted type of goods (i.e., as intangible units of output) or (2) an 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. It is the logic most frequently employed to transitioning from goods to service.

Service-Dominant (S-D) Logic places "service" (singular) – a process of doing something for another party – in its own right, without reference to goods as the primary focus of exchange activity [22, 23]. In S-D logic, goods continue to play a critical role, at least in a subset of economic exchange, in service-delivery.

Perhaps the most notable distinction between G-D logic and S-D logic can be seen in the conceptualization of service. In S-D logic, service is defined as the application of competences (knowledge and skills) for the benefit of another party [23]. The use of the singular "service" as opposed to the plural "services," as traditionally employed in G-D logic, is intentional and non-trivial. It represents a shift from thinking about value in terms of operand resources – usually tangible, static 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 in order to obtain reciprocal service – that is, service is exchanged for service. While 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, 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 [22] 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.

This "new logic" is also actually an old logic in the sense that it recaptures the foundational ideas of value creation through the reciprocal application of knowledge and skills that Smith [15] established before abandoning them to discuss national wealth. It also can be seen in the work of Bastiat, a 19th Century economist who claimed "Services are exchanged for services… it is the beginning, the middle, and the end of economic science …" [1, p. 162].

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, based upon service-driven principles, is a generalizable logic for understanding all economic activity (i.e., even when goods are involved) and thus a more robust logic for transitioning from goods to service.

However, 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” vs. “consumer” distinction (see [21]). In a value-co-creation and service-for-service and conceptualization of exchange, the notion of one party being the creator of value and the other being a destroyer is inconsistent, if not incoherent. Thus, another, more generic conceptualization of the parties is required. We identify these entities as a “service systems.”

Vargo and Lusch [22] argue for evolving a service-dominant logic in marketing to replace the goods-dominant logic that has taken hold over the last two centuries. A theory of service may follow, but first a service-dominant logic must be evolved that establishes concepts, worldview, and fundamental principles. Toward this end, , Lusch and Vargo [9, 25] propose the following ten foundational premises: (FP1) Service, the application of operant resources (skills and knowledge) for the benefit of another party, is the fundamental basis of exchange; (FP2) Indirect exchange masks the fundamental nature of exchange; (FP3) Goods are distribution mechanism for service provision; (FP4) Operant resources are the fundamental source of competitive advantage; (FP5) All economies are service economies; (FP6) The customer is always a co-creator of value; (FP7) The enterprise can not deliver value, but only offer value propositions; (FP8) A service-centered view is inherently customer oriented and relational; (FP9) All economic and social actors are resource integrators; (FP10) Value is always uniquely and phenomenologically determined by the beneficiary.

4. 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 and determining benefit (value co-creation). We call these interacting entities service systems. More precisely, we define a service system as a dynamic value co-creation 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. 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, including interaction episodes with itself.

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 co-creation interactions between service systems are termed service interactions. Each service system engages in three main activities that make up as service interaction: (1) proposing a value co-creation 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 co-creation 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 judged 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 system do all of the time – judge value being co-created with other service systems and adjusting accordingly.

Not all service systems 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. In this normative model, there are ten possible outcomes for any interaction between two service systems.

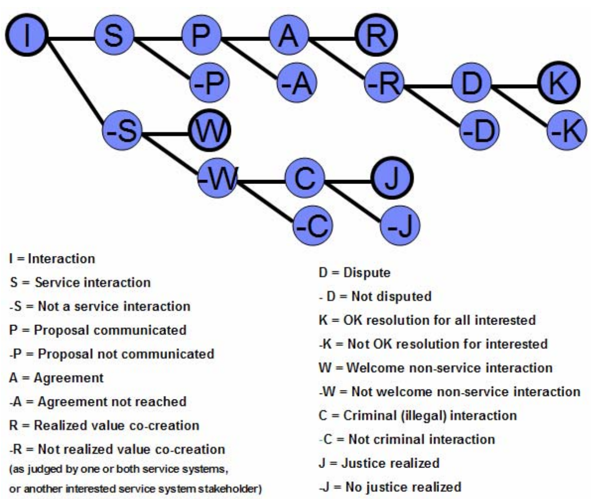

Figure 1: ISPAR model of service system interactions.

1. Outcome (R): Realization of the proposed and agreed to service interaction. For a service system with a good reputation in the population of service systems, this is the desired outcome. For example, if a person brings a document to a notary to be notarized, and the service interaction is successful, value is co-created and both service systems realize the benefit from the service interaction. The realization outcome (R) corresponds to win-win interactions between service systems.

2,3. Outcomes (-P) and (-A): A proposal may not be successfully communicated or understood by the other service system (-P), and so the interaction may be aborted. Or a proposal may be communicated, but activities between the service systems may not lead to an agreement (-A), and so the service interaction may be aborted. For example, if the requestor does not have proper identification, then the notary will not agree to notarize the document. If the requestor has not brought a document, the notary may not understand the requestor's attempt to have some abstract object notarized.

4,5,6. Outcomes (-D), (-K), and (K): The value of a proposed service interaction may not be realized, and it is possible that no dispute (-D) arises. For example, two service systems may have been collaborating on a risky venture that failed for a reason that both service systems accept as outside of their control, and hence no value is co-created and no dispute arises. Nevertheless, both service systems may have learned a great deal from the attempt. However, often when co-created value is not realized by one or both service systems, a dispute ensues. Alternatively, the two service systems may have been successful in their value co-creation efforts, but another interested service system impacted by their efforts steps forward. This may be the result of an unintended consequence. For example, a home owner may be in the process of selling their property to an organization that runs a resettlement program for families fleeing war-ravaged homelands, and the neighbors file suit to stop the sale, fearing a drop in property values. When a dispute arises, the outcome can either be a successful resolution that is acceptable to all the stakeholders (K), or a resolution that is not acceptable to all the stakeholders (-K). Tapscott has written extensively about the risks businesses take when the do not adequately understand their stakeholder webs as they seek to create value. In the case of a formal service interaction based on a formal contract between the two service systems, if a private resolution cannot be found, a law suit, and external governance mechanisms may be invoked to resolve the dispute [19].

7. Outcome (W). Many interactions between service systems are not service interactions (i.e., result in substantive value co-creation), but nevertheless the interaction may be welcomed (W) by both service systems. For example, exchanging pleasantries with a stranger that is passed on the street, or when businesses at a trade show exchange information. Such interactions may be voluntary and welcomed, but the amount of value co-created is typically very small, may be asymmetric, and the proposal and agreement exceptionally informal. However, welcomed (W) non-service interactions are not to be minimized. They often lay the foundation for future service interactions that may co-create great value. For example, when state visits between nations seek to establish better diplomatic relationships, the interactions may be welcomed, but are often a mere courtesy, and not a substantive service interaction with clear proposal and

agreements expected. Nevertheless, again it should be emphasized that welcomed (W) non-service interaction are often foundational for future service interactions of a more substantive nature.

8, 9, 10. Outcomes (-C), (-J), and (J): When the interaction between service systems is not welcome by one or both service systems (e.g., confirming by comparing boarding cards that two passengers have been assigned the same seat on an overbooked flight), a judgment must be made as to the severity of the unwelcome (-W) non-service interaction. In the case of the double booked seats, this is likely not a criminal (-C) act. However, if one arrives home to discover a stranger in one's house, or sees an unauthorized stranger wandering about in an office, the unwelcome interaction (-W) may in fact be criminal (illegal) activity. If it is a criminal activity, a series of activities undertaken by several service systems interacting can result in justice (J) if the criminal is caught and punished, or in no justice (-J) if the intruder cannot be caught or escapes prosecution.

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 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 co-creation is judged, 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.

5. Service Systems Foundations

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 judged by the system or by the system's ability to fit 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 sees the interaction as having 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). 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).

Service systems are made up of resources, both operant resources that perform actions on other resources and operand resources that are operated on [22]. Of course, determining which resources are operand and which are operant depends on the perspective of the system judging it. A machine tool, such as a hydraulic press, is an operant resource for the factory that creates tablets out of a powdered chemical; the tablet is an operant resource used to clean dishes in a homeowner's dishwasher; and the press may be the operand resource for a maintenance worker at the factory. Operant resources act on operand resources from the perspective of a judging service system.

General systems theory provides a framework for understanding complex relations in configurations of operant and operand resources [3]. But service systems are not defined by the relations and interaction of resources alone. Some operant resource must act to apply operand resources, at the very least providing the proposal, agreement, and judgment of co-creation of value. Service system boundaries are defined by the operand resources that operant resources can bring to bear. And underlying value co-creation 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 judgment of value associated with the commitment of the car and 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, it may be an operand resource for another service system. We can define an atomic service systems as one that has no service systems as operand 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 in which there is only one resource and service systems in which multiple operand resources are included. 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 economic structures [27]. 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 co-creation of value 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 co-creation.

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 value judgments. 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 may be 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 (operant resources) are assembled by the same workers (operand 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 need to be arranged within and across systems for effective value co-creation, (2) the nature of atomic service systems, and (3) methods and mechanisms of service system change. A general systems theory orientation toward service systems – particularly in light of FP9 and FP10 of S-D logic – implies service systems are evolutionary, complex adaptive systems with emergent properties (e.g., value creation).

6. The Utility of "Service Systems"

S-D logic represents a shift in logic of exchange, not merely a shift in type of product under investigation. It is a shift that Vargo and Lusch [22] 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), as well as in practice.

In this same way, we can begin to judge the utility of the service-system abstraction by its ability to help us unify concepts from disparate fields, and its ability to help us generate insights into the nature of service and service innovation. Of course it is too early to tell whether this will ultimately prove to be a useful abstraction. But for now, consider examples from the following eight disciplines.

1. Economics and Law: Williamson [28] describes two types of economic institutions, environmental institutions that define the rules of the game, and governance institutions that are required to deal 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.

2. Operations Research (OR): Mathematical modeling of business processes and supply chain networks that can be optimized is an important OR focus. Comparing OR models of the variety of types of service systems (e.g., businesses, government agencies, hospitals, etc.) might reveal a number of interesting similarities to service systems. The International Federation for Operations Research and management Science (INFORMS) has already formed a section on Service Science (see http://service-sci.section.informs.org/).

3. Industrial Engineering: Industrial engineers use modeling and simulation to design, develop, operate, and maintain production processes and systems of significant variety. The Institute of Industrial Engineers (IIE) has established an area to explore service systems research.

4. Computer Science: Multi-agent Systems (MAS), mechanism design theory, and service-oriented architectures are all areas of considerable overlap with the formalization of service systems.

5. Information Science: This is one of the newest bachelor and masters programs in the US. The design of information systems to support high quality service systems ranging from hospitals to universities is an area of investigation.

6. MBA and Management Consulting: Businesses are a very important type of service system. Many of the findings in management, strategy, finance, operations, marketing about businesses can be applied to the notion of service systems.

7. Management Information Systems and Knowledge Management Systems: More and more service interactions are mediated by technology, and increasingly the ability to reuse knowledge assets in an organization is key to their success. MIS and KMS are key resources inside more and more sophisticated service systems.

8. Organizational Studies and Organizational Learning: A number of people have asked, "Aren't service systems just organizations?" People are service systems, but an individual person is rarely considered an organization. That said, the study of service systems, especially composite service systems, can benefit enormously from what is already known about organizations and the way they learn (or fail to learn).

It has been suggested that the notion of the service system may be an interface for communication among disciplines. Though this is certainly true, the deeper motivation is that service systems are already being studied from multidisciplinary perspectives, and service science is seeking to develop the science of service systems and service system interactions [18].

7. Concluding Remarks

Challenges and opportunities for service science abound [10, 17]. Chief among the challenges is 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 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 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 innovation.

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