ANSWERING KEY QUESTIONS FOR SERVICE SCIENCE

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ANSWERING KEY QUESTIONS FOR SERVICE SCIENCE

Research paper

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Abstract

A three-month consultation process following the Cambridge Service Science, Management, and Engineering Symposium in July 2007 produced a white paper called “Succeeding through service innovation: A service perspective for education, research, business and government” (IfM and IBM, 2008). The white paper’s content served as an important inspiration for subsequent service science research. Among other ideas, it identified five “key questions” for service science related to architectures of service systems, building blocks, life cycles, optimization, and outcomes of service systems. This paper addresses the white paper’s challenge by providing a conceptual rationale and then answering each of the key questions. It starts by discussing the series of ideas that form a basis for answering the questions. Its final section looks at each question in turn and explains how the previously discussed ideas, taken in combination, answer each question in a way that is coherent and consistent with the other answers. In essence, this paper is an existence proof illustrating that there is at least one coherent and consistent set of answers for these key questions. Ideally, the existence of one set of answers will encourage the creation of answers from other viewpoints, ultimately supporting future developments in service science.

Keywords: Service, Service science, Service system, Work system, Encapsulation

1 Key Questions about Service Science

In July 2007, IBM and Cambridge University’s Institute for Manufacturing (IfM) “orchestrated an international symposium to help distil the key issues surrounding the nature of service and to identify guidelines for future development. The two-day meeting was attended by a group of leading academics and senior business leaders with a wide and deep knowledge of service research and practice.” (IfM and IBM, 2008, p. 5). Subsequent consultations led to a white paper called “Succeeding through service innovation: A service perspective for education, research, business and government.”(IfM and IBM, 2008). Over 115 people from 20 countries provided feedback during the process. (p. 23)

This paper directly addresses five “key questions for service science” posed by the position paper (IfM and IBM, 2008, p. 7). Those key questions include:

1) What are the architectures of service systems?
2) How can service systems be understood in terms of a small number of building blocks that get combined to reflect the observed variety?
3) How might architectures and building blocks help us understand the origins, lifecycles and sustainability of service systems?
4) How can service systems be optimized to interact and co-create value?
5) Why do interactions within and between service systems lead to particular outcomes?
**Goal and organization.** This paper is a conceptual contribution that provides an internally consistent set of answers to the five questions. Its operational perspective on service and service systems can be contrasted with other approaches such as service dominant logic that are mostly about the nature of markets, competition, and, more recently, service ecosystems. This paper’s topical coverage and its answers to the five key questions are offered as a step forward at a time when much of the literature on service and service systems skirts over fundamental disagreements and inconsistencies about the nature of service and service systems.

This paper is organized as a sequence of seven sections (sections 2-8) that focus on different service-related topics that form the basis of a coherent and internally consistent operational view of service and service systems. That view of service and service systems leads directly to answers to all five of the key questions for service science. The main points in that view are explained through the following sequence of topics (with “⇒” indicating that the previous topic has implications for the next):

- (Sec. 2) desirability of covering all services and service systems, not just service marketing issues ⇒ (Sec. 3) definition of service that covers all services and service systems ⇒ (Sec. 4) recognition of different valid portrayals of service consistent within the definition ⇒ (Sec. 5) emphasis on the concept of product/service and related design dimensions instead of emphasis on classification as product vs. service ⇒ (Sec. 6) treatment of service systems as work systems based on work system theory and a metamodel that implies operational views of coproduction and value co-creation ⇒ (Sec. 7) use of “degree of encapsulation” (from computer science) to visualize service concepts such as service interaction, coproduction, and value co-creation ⇒ (Sec. 8) recognition of the need to include variability and noncompliance in a realistic operational view of services and service systems.

A concluding section shows how the perspective and concepts discussed in those seven sections answers all five of the key questions for service science. Overall, this paper’s main ideas illustrate the possibility of attaining much more clarity about the meaning of service and service system across the wide range of services and service systems in today’s business and social world.

## 2 Coverage of All Services and Service Systems

Service science should apply to the complete spectrum of services and service systems encountered in everyday life, not just to specific types of services and service systems that are of interest to one researcher or another who may specialize in service marketing or service operations or service computing. Service science should apply to service offerings such as haircuts, gardening services, medical care, hospitality, education, remote maintenance, public utilities, transportation, package delivery, consulting, Web services, network maintenance, architectural design, process outsourcing, bug fixes, customer support, and software customization. The spectrum of services includes the following:

- services for external customers and for internal customers (Service science should cover more than services marketed to external customers. For example, a merger between a supplier and customer into a single company should not transform a supply service into a non-service.)
- automated, IT-reliant, and non-automated services. (Service science should not assume that services necessarily involve interactions between people or experiences perceived by people.)
- customized, semi-customized, and non-customized services. (Service science should not assume that services necessarily are customized.)
- personal and impersonal services. (Service science should recognize that services can be delivered through any combination of personal relationships and impersonal transactions.)
• scripted and non-scripted services. (Service science should encompass services that are designed for delivery through scripts and other services designed to be provided through improvisation.)

• long-term and short-term services. (Service science should encompass services that are delivered once and other services may be delivered repeatedly for years.)

• simple and complex services. (Focusing only on complex systems is impractical. Service science needs to cover simple systems as a step toward making sense of complex systems.)

• services with varying degrees of self-service responsibilities. (The service science interpretation of self-service should be consistent with interpretations of other service arrangements.)

3 Definition of Service

Basic definitions of service should cover the entire spectrum of services identified in Section 2 and should apply to all situations that most people consider to be services. Classification as a service versus nonservice should not change with incremental changes in whatever is being offered to customers. Thus, a physical thing that is manufactured, delivered, installed, and used, such as a jet engine or refrigerator, should not flip from a nonservice to a service if a financial arrangement changes. For example, despite the many important financial and operational consequences of the business arrangement of paying for “thrust per hour” for jet engines (Johnstone et al., 2009), only part of the supply chain for manufacturing, installing, and maintaining the engine changes when that type of approach is used. Similarly, a supply service should not flip to nonservice if a supplier firm and customer firm merge but continue performing essentially the same supply and consumption processes. More generally, definitions of service that rely on specific characteristics of activities or service situations do not apply to many situations that most people would view as services. Examples of such characteristics include intangibility, heterogeneity, inseparability, perishability (IHIP), no transfer of ownership, interaction between providers and customers, coproduction, simultaneous production and consumption, value co-creation, and win-win value propositions. Vargo and Lusch (2004b) mentioned shortcomings of trying to associate services with the IHIP characteristics. Similar comments apply to the other characteristics as well. In a specific example, hip replacement surgery should be viewed as a service even though the patient is unconscious during a surgery that results in the patient’s ownership of an implanted device that is tangible, was produced before it is installed, and is not perishable. Obviously it is possible to argue about whether the surgery is intangible even though the device is tangible, and whether the assigned time in the surgery suite is perishable even though the device is not perishable. Arguments about such distinctions are unrelated to generating better surgical results.

Viewing most activities in organizations as services. The following definition applies to all service situations mentioned at the beginning of this section. “Services are activities or groups of activities performed to produce or facilitate benefits for others.” That definition covers almost everything that happens in organizations, with the exception of situations where an individual performs work whose direct benefits will be invisible to others, such as maintaining a personal customer spreadsheet or shadow IT system containing valuable information that is not included in an official corporate IS.

Aside from its generality, an important benefit of this very broad view of services is its implication that understanding and analyzing most processes and activities in organizations requires considering how customers of those processes and activities will attain value from whatever those processes and activities produce. That essential aspect of service is often missing from detailed analysis of processes. Also, saying that almost everything that happens in organizations can be viewed as services is generally consistent with foundational premise #5 of service dominant logic, “All economies are service economies.” (Vargo and Lusch, 2004a, 2008, 2016). On the other hand, the underlying
assumption that services are commonplace may seem disappointingly inconsistent with common beliefs that something is very special about services in general.

4 One Definition of Service, Many Valid Portrayals of Service

The definition of service as “activities or groups of activities performed to produce or facilitate benefits for others” is quite general, but there are many situations in which managers or researchers find it important to emphasize a particular focal point for describing, analyzing, designing, or evaluating services. The term “portrayal of service” can be used to identify common focal points of that type. This is similar to the way people may be portrayed as parents, workers, taxpayers, or citizens for important purposes even though those terms do not define who they are. All of the following portrayals of service are consistent with or build upon viewing services as activities or groups of activities performed to produce or facilitate benefits for others.

- **Service as acts for the benefit of others.** This portrayal mirrors the definition above and suffices as a starting point for other portrayals. It is generally consistent with service definitions in Kotler and Keller (2006, p. 402), Vargo and Lusch (2008, p. 6), and Grönroos (2011, p. 285).

- **Service as a sector of the economy.** The widely noted predominance of service in advanced economies is unrelated to detailed understanding of specific services and service systems in organizations. Every enterprise operates through internally and externally directed service systems regardless of whether it is in the agriculture, manufacturing, or service sectors of the economy.

- **Services as outcomes.** Managers of IT service organizations and many other service providers need to describe services from a customer’s viewpoint. Some of those managers prefer to portray service offerings in relation to specific outcomes, often with accompanying service level agreements, because they recognize that their customers are less interested in activities that providers perform and are more interested in beneficial outcomes that they will receive. This portrayal is reflected in service definitions in Hill (1977, p. 318), Clerc and Niessink (2004 p. 104), ITIL (2011, p. 66), and Iqbal (2014).

- **Service as a response to a request.** Definitions such as those in Pine and Gilmore (1999, p.8) and Sampson and Froehle (2006, p. 331) imply that services always involve a request from the customer and a response from a provider. Focusing on that portrayal leads to emphasizing the content and form of the requests and responses. On the other hand, focusing on requests and responses may underemphasize the operation of the service system that produces the response.

- **Services as coproduction.** Definitions such as those in Sampson and Froehle (2006, p. 331), Sampson 2012, p. 187, Vargo and Lusch (2008), and Belogazov et al. (2014, p. 78) state or imply that coproduction is an essential aspect of service. This portrayal of service emphasizes co-activity of providers and customers. That co-activity may occur during a single step in a provider’s service production process or may occur throughout the process. In a minimal form of coproduction, the customer activities involve nothing more than stating a service request that launches a service instance. More extensive coproduction involves direct customer participation in a provider’s production activities, e.g., roles of patients in medical diagnosis, clients in physical therapy, students in education, and clients in the development and testing of customized software.

- **Services as value co-creation.** In this portrayal, the provider is involved in the customer’s value creating process. That happens when a physician interacts with a patient. It does not happen when a manufacturer produces a tennis racquet that a tennis player receives and uses two years later. Despite service definitions that emphasize value co-creation (e.g., Spohrer and Maglio (2010), Breidbach et al, (2012, p. 428), and (Jaakkola and Alexander (2014, p. 248)), there is debate about whether value co-creation is inherent in services. Foundational premise #6 in the most recent revision of service dominant logic (Vargo and Lusch, 2016) says “value is cocreated by multiple ac-
tors, always including the beneficiary.” Grönroos (2011) offers a contrasting view that customers create value for themselves and providers may seize the opportunity to facilitate that value creation.

- **Services as economic exchange.** This portrayal of service assumes that service must involve economic exchange, and sometimes assumes that economic exchange is the essence of service. Foundational premise #1 in Vargo and Lusch (2008, 2016) says that service is the fundamental basis of exchange. Definitions in IfM and IBM (2008, p. 16) reflect a focus on exchange between what are called “provider service systems” and “customer service systems.” A practical shortcoming of this portrayal is that many services such as inwardly directed services within enterprises do not involve direct economic exchange. Even if all parties involved in those inwardly directed services are paid by the same enterprise, the creation, maintenance, and improvement of such services often does not mention economic exchange.

- **Services as encapsulated functionalities.** Service computing brings a completely different portrayal. According to Oberle et al. (2013, p. 158) “services constitute encapsulated and exposed functionality drawing from core artifacts, e.g., those related to business processes, applications, objects, and resources. ... Whereas business process activities are said to be orchestrated across collaborating resources, service capabilities are delivered to consumers by providers. ... They provide functionality aimed at delivering value to consumers in terms of expected outcomes, subject to delivery constraints.” Several earlier sources clarify the nature of such services. According to Cherbakov et al. (2005), service “is generally implemented as a course-grained, discoverable software entity that exists as a single instance and interacts with applications and other services through a loosely coupled (often asynchronous), message-based communication model.” Brown et al. (2005) notes, “the component that consumes business services offered by another business component is oblivious to how the provider created the business service.”

**Contradictory assumptions.** Assumptions underlying the portrayal of service as encapsulated functionality are completely opposite from assumptions underlying the portrayal of service as coproduction or value co-creation. Coproduction and value co-creation generally assume mutual empathy, mutual visibility, and mutual adaptation between the provider and customer. Encapsulated functionality assumes no visibility, communication through coded, preformatted messages, and no provider or customer awareness of the other party’s state or concerns beyond information in a coded message. These mutually contradictory views of service are a source of confusion about the content and nature of service science. As discussed later, degree of encapsulation can be seen as a valuable service design variable that encompasses coproduction and value co-creation.

## 5 Replacing Product vs. Service with Product/Service

When describing, analyzing, designing, or evaluating offerings for internal and/or external customers, definitive classification of that offering as either a product or service is rarely important. To the contrary, a large percentage of offerings to internal and/or external customers combine some characteristics that are often associated with products and others that are often associated with services. Frequently an improvement in a particular offering may make some aspects of it more product-like in an everyday sense and other aspects of it more service-like. (This discussion uses the terms product-like and service-like in relation to characteristics that are often associated with products or services in everyday speech, but that are not the basis of definitive classifications.)

In this paper the terms **product/service** and **product/service offering** designate something that is produced for internal and/or external customers and that may have a combination of product-like and service-like features. Aside from bypassing product vs. service distinctions that are unnecessary from an operational perspective, this approach is consistent with increasing use of terms such as
servitization (Vandermerwe and Rada, 1989) and product-service system (e.g., Cavalieri and Giuditta, 2012; Gokula et al., 2012; Gaiardelli et al. 2014).

To illustrate the tenuousness of any imagined boundary between products and services, consider how each variation in the following educational offerings changes the balance between product-like and service-like features: 1) a book; 2) a book plus interactive exercises; 3) a course offered on www.youtube.com that is packaged with a book and interactive exercises; 4) the same course with limited question answering by a teaching assistant; 5) the same course with the much more availability of teaching assistants; 6) an ongoing personal or small group tutorial by an expert instructor supported by the availability of books and videos. The first option, just a book, is definitely product-like. The sixth option, the tutorial is much more service-like even though the books and videos are product-like features. Most designers of the educational offering would care about finding a mutually beneficial mix of product-like and service-like features that satisfies or delights customers. It seems unlikely that they would care about the precise transition point from product to service.

**Design dimensions rather than yes/no distinctions.** Recognizing that any product/service may combine product-like and service-like characteristics leads to the use of design dimensions that use many of the concepts mentioned earlier in relation to definitions and portrayals of products and services. Table 1 presents a set of design dimensions, each of which goes from a characteristic often associated with products (left side of the table) to an opposing characteristic often associated with services (the right side of the table). Any particular product/service may be closer to the left side of the table on some dimensions and closer to the right side on other dimensions. For example, a particular educational offering might be highly intangible, highly homogeneous, partially separable, partially perishable, partially involving transfer of ownership to customers (e.g., books and course materials), and might involve a small amount of interaction between providers and customers.

<table>
<thead>
<tr>
<th>End point frequently associated with products</th>
<th>Range of possible values on each dimension</th>
<th>End point frequently associated with services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tangible</td>
<td></td>
<td>Intangible</td>
</tr>
<tr>
<td>Homogeneous (not customized)</td>
<td></td>
<td>Heterogenous (customized)</td>
</tr>
<tr>
<td>Separable (production process is separate from customer’s value creation process)</td>
<td></td>
<td>Inseparable (production process overlaps with customer’s value creation process)</td>
</tr>
<tr>
<td>Durable (will retain value even if not used soon)</td>
<td></td>
<td>Perishable (will lose much or all of its value if not used soon)</td>
</tr>
<tr>
<td>Transfer of ownership from provider to customer</td>
<td></td>
<td>No transfer of ownership from provider to customer</td>
</tr>
<tr>
<td>Minimal interaction between providers and customers</td>
<td></td>
<td>Extensive interaction between providers and customers</td>
</tr>
<tr>
<td>Produced and later transferred to customers</td>
<td></td>
<td>Coproduced through joint effort of providers and customers</td>
</tr>
<tr>
<td>Production process not visible to customers</td>
<td></td>
<td>Production process visible to customers</td>
</tr>
<tr>
<td>Separation between production and consumption</td>
<td></td>
<td>Simultaneous production and consumption</td>
</tr>
<tr>
<td>Value created by producer and transferred to customers</td>
<td></td>
<td>Value co-created by joint effort of providers and customers</td>
</tr>
<tr>
<td>Transaction based interactions with customers</td>
<td></td>
<td>Relationship based interactions with customers</td>
</tr>
</tbody>
</table>

*Table 1: Continuous design dimensions for product/service offerings (based on Alter, 2010, p. 207)*
Table 1 highlights the perpetual challenge of calibrating product/service offerings across all of the dimensions in order to generate the most favorable trade-offs between provider interests (such as efficiency, repeatability, complexity, and ease of training) and customer interests (such as cost to the customer, quality perceived by the customer, responsiveness, and reliability).

6 Viewing Service Systems as Work Systems

Many concepts for summarizing and analyzing service systems are provided by a subset of general system theory called work system theory (WST) plus extensions of WST. The concept of work system has been used for many decades by sociotechnical researchers. It appeared in the first volume of *MIS Quarterly* in Bostrom and Heinen (1977), which viewed a sociotechnical work system as a combination of a technical system and social system. This paper’s view of work systems treats them as integrated systems whose components combine social and technical aspects.

Figures 1 and 2 outline how concepts related to work systems can be used to represent service systems in much greater depth than brief definitions of the concept of service system. Figure 2 also provides a basis for visualizing every portrayal of service in Section 4 except service as a sector of the economy.

**Work system theory.** As shown in Figure 1, WST consists of the definition of work system, the work system framework (nine elements of a basic understanding of a work system) and the work system life cycle model (summary of how work systems evolve through planned and unplanned change). The details of WST have been explained many times (e.g., Alter, 2013, 2015b).

Service systems are work systems that produce product/services and that may or may not involve coproduction by customers and value co-creation. A basic understanding of a service system requires an understanding of its participants, processes and activities that they perform, the product/services that are produced, the customers, and so on for the other elements of the work system framework. Note that a service system’s customers may or may not be participants in the service system.

1) Definition of work system: a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce specific product/services for specific internal and/or external customers.

2) Work system framework

3) Work system life cycle model

**Figure 1. Three components of work system theory (Alter, 2013, 2015b)**

**Work system metamodel.** Figure 2 is the top part of the sixth of a series of work system metamodels that outline more detailed, operational views of a work system than are provided by the work system framework. The work system framework is useful for summarizing a work system (service system)
and achieving mutual understanding of its scope and nature, but is less effective for detailed analysis. The more complete and rigorous metamodel attains more precision about concepts required for deeper analysis by reinterpreting each element of the work system framework in more detail. For example, information becomes informational entity (of which various types are named), technology is divided into tools and automated services, activities are performed by three types of actors, and so on.

![Excerpt from work system metamodel](image)

**Figure 2.** Excerpt (top part only) from work system metamodel (Alter, 2016)

The version of the metamodel in Figure 2 extended previous versions in order to clarify links between provider resources and value creation, thereby illuminating operational interpretations of resources and value creation in service-dominant logic. Starting at the top, the metamodel says the following:

- **Enterprises** and **value constellations** (Normann and Ramirez 1994) consist of **work systems**.
- **Work systems** always contain at least one **activity**. They may contain one or more **business processes** if a set of **activities** is sufficiently interrelated and sequential to qualify as a process.
- **Activities** use **resources** to produce one or more **product/services** that may be used as a **resource** for subsequent activities and/or may contribute to a **product/service offering**. A **product/service offering** may combine multiple **product/services**. Thus, only some of the **product/services** that are produced within a work system contribute directly to **product/service offerings** that facilitate value creation by **customer work systems**, and hence value for **customers**.
- **Product/service offerings** may or may not be governed by a **service level agreement**. Formal service level agreements are essential in some situations, especially for service offerings defined through extensive negotiations, but are unnecessary in other situations.
• Customer work systems create value for customers using their own resources plus product/service offerings produced by the provider work system.

• Resources used by an activity may include human resources (participants), informational resources, technological resources, and other resources. The metamodel includes specific types within each resource type to minimize the likelihood of omissions in an analysis.

• Activities are performed by actor roles that can be performed by three types of entities, noncustomer participants, customer participants, and encapsulated services that may or may not be automated services. In medicine, a doctor is a noncustomer participant, the patient is a customer participant, and software that identifies drug interactions is an encapsulated service.

• The outcome of activities that involve participants depends on attributes of those participants, such as knowledge/expertise, skills/capabilities, performance metrics, and motives.

• An encapsulated service can play an active role in a work system activity. The upward arrow from encapsulated service to work system says an encapsulated service is a type of work system.

6.1 Representation of previously mentioned portrayals of service

The metamodel’s structure can be used to express all of the portrayals of service in Section 4 with the exception of service as a sector of the economy (since the metamodel is about work systems, not about economies). Covering the various portrayals of service is significant because it goes far beyond arguments about whether one or another portrayal of services is preferred in certain circumstances.

• Service as acts for the benefit of others. The metamodel says that work system activities produce product/services from activities that contribute to product/service offerings received by customers.

• Services as outcomes. The metamodel says that value for the customer comes from the customer’s work system. A provider cannot guarantee what will be produced by a customer’s work system. On the other hand, the metamodel says that the work system produces product/service offerings that can be guaranteed through service level agreements. Under those circumstances it is reasonable to view the product/service offering as an outcome that the customer receives and uses.

• Service as a response to a request. In the metamodel, resources for action include informational entities. Those informational entities can include customer requests to launch service instance.

• Services as coproduction. According to the metamodel, coproduction occurs when a customer performs activities in at least one work system activity in a provider’s service system.

• Services as value co-creation. The metamodel says that value creation occurs in the customer’s value creating work system. Accordingly, value co-creation can occur when one or more activities in the customer’s work system coincide with activities in the provider’s service system.

• Services as economic exchange. While the metamodel says nothing about economic exchange, one or more of the activities in a service system can be devoted to economic exchange.

• Service as an encapsulated functionality. The metamodel says that an actor role can be performed by an automated service, which is an encapsulated functionality, as is explained next.

7 Using Degree of Encapsulation to Visualize the Range of Relationships between Providers and Customers

The concept of encapsulation is useful for discussing service systems because it provides a container for understanding important service-related topics such as coproduction, value co-creation, and cus-
customer experience. A prime reason for the disconnect between typical marketing and computer science views of service is that computer science assumes that encapsulation is essential in services while marketing generally assumes the opposite, i.e., substantial visibility and involvement by customers. The degree of encapsulation for a service system can be described along the following dimension:

- **No encapsulation.** Customers are extensively involved in most or all service system activities, as in physical therapy services, tennis lessons, and other highly coproduced services. (In some cases there may be involvement by other stakeholders generally considered external to service system.)

- **Customer participation beyond providing guidance.** Active customer involvement in front stage activities occurs along with backstage activities by the provider. An example is a software development project whose customers document requirements and participate in extensive discussions and negotiations.

- **Customer guidance only.** Customers interact by stating preferences and possibly reviewing progress at various points, but the production work is done with little or no customer involvement. Housecleaning and gardening services are examples.

- **Total encapsulation.** A totally encapsulated service is launched by a request or condition, is executed with no direct customer involvement or visibility, and produces an outcome that the customer receives and uses. This is the basic idea of service computing as expressed in the Unified Service Description Language (USDL) (Oberle et al. 2013).

Consistent with the discussion of the different portrayals of service in Section 4, the different degrees of encapsulation help in visualizing the operational meaning of terms such as service interaction, coproduction, value co-creation, customer and provider responsibilities, customer experience, and self service. They also help in understanding the extent to which service outcomes can be guaranteed. A provider’s ability to control or guarantee any particular outcome decreases as the degree of encapsulation decreases because less encapsulation implies greater impact of the customer’s activities (and any related variability, inconsistency, and noncompliance) on the outcome.

- **Service interactions.** Service interactions occur wherever customer participants and noncustomer participants play actor roles in the same activity. The only service interaction in a totally encapsulated are the interfaces for requesting the service and receiving the requested responses.

- **Coproduction.** Coproduction occurs in any work system activity in a provider’s service system where service interactions occur. If the mere presence of coproduction implies that a set of activities is a service, then a 20-step process consisting of one customer request followed by 19 provider activities would qualify as a service. While that might satisfy a need for a definition, it is far more useful to examine the extent and form of coproduction, and ask whether more coproduction or less (i.e., less encapsulation or more) would be preferable for providers and/or customers. Changes that are beneficial for providers might not be beneficial for some customers, and vice versa.

- **Value co-creation.** The metamodel says that value co-creation occurs wherever value creating activities in customer work systems that create value for customers coincide with activities in provider work systems. The service literature contains debates about whether value co-creation is essential or optional. In contrast with service dominant logic saying “value is cocreated by multiple actors, always including the beneficiary” (Vargo and Lusch, 2016), the metamodel reflects the Grönroos (2008; 2011) view that firms have opportunities to facilitate value creation by customers through provision of resources for customer use. Value co-creation is optional since providers decide whether and how to engage directly with customers’ value-generating processes.

- **Customer and provider responsibilities.** Both customer and provider responsibilities within a provider work system are implied by activity descriptions that identify actor roles performed by customer participants, noncustomer participants, and encapsulated services. A provider ser-
vice system’s degree of encapsulation decreases as customers take more responsibility for performing actor roles in the provider’s system. Also, customer responsibilities are evident from the fact that value-related outcomes depend on customer work systems that produce value for customers.

- **Self-service.** In a self-service system (e.g., buying books online), customer participants use resources (such as web sites) that are made available by a service system owner to allow the customer to perform activities independently without interacting with noncustomer participants. Self-service systems are non-encapsulated as a whole because customers drive all of the activity.

- **Customer experience.** Customer experiences start during any coproduction that occurs but also include any receipt and use of product/service offerings within the customer work system that produces value for customers. Thus, the customer experience combines the experience of interacting with the provider and the experience of attaining value that is facilitated by product/service offerings, whether or not the provider service system is at all visible to customers at that point.

- **Value proposition.** The metamodel represents an operational perspective on service and service systems and therefore does not mention the term value proposition, which is more associated with marketing communications that may be imprecise, exaggerated, or intentionally misleading. Assuming that value propositions are meant to be operationally realistic, the concept of value proposition can be viewed as a specification of the resources the customer would have to give up (e.g., money, time, effort) in order to receive and use a product/service offering plus an explanation of why that would solve a problem for the customer in a genuinely beneficial way.

### 8 Operational Variability and Noncompliance

A realistic operational perspective on service and service systems should consider random and nonrandom variability in how activities will be performed. It should also consider the possibility of provider and/or customer noncompliance to guidelines and expectations related to activities and responsibilities within provider service systems and/or customer work systems that create value for customers. Those factors result in uncertainty about achieving desired performance levels and other desired outcomes. Implications of recognizing operational variability and noncompliance include the following:

- **Random and nonrandom variability.** Both operational activities and product/services are susceptible to random and nonrandom variability that may affect a service system’s internal performance and its outcomes for customers.

- **Design errors and design obsolescence as a cause of inadequate performance.** Compliance to a flawed and/or obsolete process can generate disappointing results.

- **Unanticipated changes in service systems or product/services.** Unanticipated changes can occur through adaptations and institutionalized workarounds.

- **Possibilities of noncompliance by providers and customers.** The design of service systems sometimes assumes that providers and customers will comply with process specifications, guidelines, and business rules built into the design. That assumption is frequently incorrect.

- **Beneficial noncompliance and detrimental compliance.** Both compliance and noncompliance may be beneficial or detrimental. Detrimental noncompliance may occur due to factors such as accidents, poor training, exceptions, resistance to management, sabotage, and fraud. In contrast, beneficial noncompliance may occur when when workarounds are necessary due to unexpected contingencies, outdated processes, and other factors. (e.g., Alter, 2014). There also are situations when compliance is detrimental, as when specifications or guidelines are outdated or do not fit exceptions and other contingencies that call for a different approach. A possibly surprising example of detrimental compliance (Alter, 2015a) also occurs in “working to rule,” a type of labor action in which employees bring work to a standstill by performing only contractually specified activities.
• **Multiple paths to non-realization of value propositions.** The various forms of operational variability and noncompliance constitute multiple paths to non-realization of value propositions.

### 9 Conclusion: Answers to “Key Questions for Service Science”

The introduction said that this paper’s main ideas represent progress in answering the five “key questions for service science” mentioned at the outset. Contributions of Sections 2-8 were as follows:

- Section 2 identified the scope of services and service systems covered by service science.
- Section 3 provided a definition of service that covers most activities usually viewed as services.
- Section 4 identified valid portrayals of service that are useful for various purposes.
- Section 5 proposed focusing on product/services and provided related design dimensions.
- Section 6 used work system concepts to outline service systems and explore related concepts.
- Section 7 used degree of encapsulation to elaborate on important service concepts.
- Section 8 noted that variability and noncompliance often affect intended outcomes.

This concluding section applies the ideas in Section 2-8 to provide a brief answer to each question. It also mentions a related challenge (highlighted by “⇒”) for any other coherent perspective for answering the five questions. For the sake of brevity it answers the second question before the first.

**How can service systems be understood in terms of a small number of building blocks that get combined to reflect the observed variety?** The concepts in the work system framework, work system metamodel, and the design dimensions constitute a relatively small number of building blocks that provide sufficient variety for describing and analyzing service systems. Use of those building blocks to reflect on central concepts in the service literature was demonstrated in Sections 5, 6, and 7.

⇒ The building blocks presented in Sections 5, 6, and 7 are not the only possible approach. It would be useful and interesting to compare the building blocks from Sections 5, 6, and 7 with other approaches such as those mentioned in relation to the next question.

**What are the architectures of service systems?** The building blocks mentioned above suffice for describing and analyzing service systems that fit anywhere within the wide range of relevant services that was identified in Section 2. The wide range of services brings many combinations of positioning along the dimensions in Table 1, thereby casting doubt on the feasibility of any attempt to identify 5 or 10 or 20 generic architectures that in combination span the scope of service science.

⇒ This paper presents a particular view of service systems. Other models or definitions of service systems appear in IfM and IBM (2008, p. 16), Ferrario et al. (2011, p. 6), Nardi et al. (2013, pp. 179-181), Cardoso et al. (2014), and elsewhere. It would be interesting to explore whether those or other alternatives lead to coherent and internally consistent answers to all five questions.

**How might architectures and building blocks help us understand the origins, lifecycles and sustainability of service systems?** The work system lifecycle model in Figure 1 describes how work systems (service systems) evolve over time through a combination of planned and unplanned change. Additional research on workarounds, compliance, and noncompliance could enrich the realism of the framework by explaining more about the nature of unplanned change and how it unfolds.

⇒ It would be interesting to see whether other views of service and service systems lead to different views of a service system lifecycle, and whether and how those views take into account combinations of planned change, unplanned change, variability, compliance, and noncompliance.

**How can service systems be optimized to interact and co-create value?** The work system metamodel suggests reasons for questioning whether service systems can be optimized to interact to co-
create value, especially when different customer work systems are owned and controlled by different customer enterprises and may not be visible to designers and managers of the provider service system. On the other hand, service systems that serve internal customers might be jointly optimized with other inwardly directed service systems within the same enterprise. Even in that case, any genuine notion of optimization would require a deeper level of analysis than is usually performed in most organizations.

=> It would be interesting to see whether other views of service and service systems provide promising approaches to this type of optimization, especially if external customers are involved.

**Why do interactions within and between service systems lead to particular outcomes?** Typical interactions within service systems can be described by the operational aspects of the metamodel (activities, resources, product/services, etc.). A combination of variability and noncompliance related to the provider’s service system and lack of visibility and/or control of a customer’s coproduction activities and value creating work systems implies that outcomes of most service systems are far from deterministic. Various forms of simulation might generate probabilistic ranges of outcomes for specific cases, but those simulations would be complex, especially for non-mechanical service systems.

=> It would be interesting to see whether other approaches provide reliable ways of linking outcomes to interactions within and between service systems.

### 9.1 Beyond the Five Questions

Beyond answering the five questions, this paper’s operational perspective on service and service systems suggests a practical route for exploring issues typically encountered when describing, analyzing, designing, and evaluating services and service systems. That route covers a typical systems analysis and design sequence: 1) identify the product/service and service system, 2) use service and work system concepts to describe and evaluate the situation in depth, 3) identify possible directions for improvement, and 4) decide on operational improvements that should lead to greater mutual benefits for providers and customers. The next step is to apply this perspective on service systems and service concepts such as coproduction and value co-creation to a broad range of service situations to demonstrate its benefits and to find areas for further improvement.

### References


