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# From Resources and Activities to Value for Customers within Systems of Service Systems

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## ABSTRACT

This paper addresses important challenges related to the 2013 SIG-SVC workshop's theme, "Delivering and Managing Services in Systems of Service Systems." It provides an operational view of systems of service systems (SOSS) in the form of a new metamodel that significantly extends previous metamodels related to work systems and service systems. An operational view of this type is necessary for understanding and analyzing existing service systems and for designing improvements and new service systems.

The metamodel's perspective on service and service systems agrees only partially with service dominant logic and other current ideas in service science. The paper starts by explaining an integrated view of those topics. It then proceeds to explain the metamodel itself, including entity types and relationships between entity types. It discusses why and how the metamodel includes many common concepts from service science explicitly, supports inferences about other concepts, and omits other service science concepts altogether. The concluding section summarizes ways in which the metamodel serves as a lens for topics related to SOSS. Those topics include what is meant by SOSS, documentation of an SOSS, visibility and vigilance in an SOSS, loose or tight coupling, emergent properties, resource availability, system interactions, interference and points of failure, dealing with change, and agent based modeling.

Keywords: service system, work system, service system metamodel, system of service systems

## EXTENDING A PREVIOUS SERVICE SYSTEM METAMODEL

The theme of the SIG SVC 2013 workshop, "Delivering and Managing Services in Systems of Service Systems" brings daunting challenges. The Call for Papers says, "The world as we know it today is characterized by complicated, sometimes complex social-technical service systems which surround us at every moment." … "Enterprise resource planning systems, supply chain management system, financial transaction systems and many more have to work together in an interactive, automated or semi-automated way. These systems … are dynamic and constantly changing. Maturing systems are decommissioned, new systems are added, older systems are revitalized, additional functionalities are added to existing systems; all of which has created a complicated network of heterogeneous "service system[s] of service systems" of different age, quality, reliability, and performance, which may develop their own dynamics." … "Understanding 'service systems of service systems' is becoming increasingly crucial for prudent management of emerging service systems risks." … "Why is it so difficult to manage service systems of service systems and what need[s] to be done to improve [these systems]?"

This paper addresses the workshop's theme directly. It contributes to the understanding of systems of service systems (SOSS) by extending previous versions of a metamodel that was initially developed to address "the long standing gap between technical and sociotechnical views of IT-reliant systems in organizations" by providing "an integrated set of concepts that extend and clarify the work system framework and related work system concepts, thereby helping in understanding, analyzing, and designing technical and sociotechnical systems." (Alter 2010, p. 1). Subsequently the metamodel was adapted to address "service system analysis and design based on an operational view of service that traverses and integrates three essential layers: service activities, service systems, and value constellations" (Alter 2012b, p. 1). A revised subset of the latter revision clarified the role of resources in the operation of service systems (Alter 2012c) but said nothing about value constellations or systems of systems.

To distinguish this paper's new version of the metamodel from previous versions, it will be called the RAVC metamodel (from Resources and Activities to Value for Customers). Adding new concepts and clarifying other concepts makes this metamodel more useful for understanding, analyzing, and designing specific service systems and for understanding (or debating) the nature of service systems in general and within the context of SOSS. Specific extensions of previous versions include the following:

1) Consistent with this workshop's theme, the RAVC metamodel explicitly states that a service system may be part of an SOSS.
2) The metamodel includes the concept of value for customers. The potential usefulness of including value in this way was illustrated in Alter (2013a) with an example of a proposed tool called a value blueprint, which takes the general form of a service blueprint (Shostak 1984; Bitner et al. 2008) while including rows for activities and also rows for specific, identifiable value perceived by service customers and service providers.
3) The metamodel includes both a service system that produces or co-produces a service and a customer work system that creates or co-creates value for the customer. Any customer activity that creates or co-creates value for customers is assumed to be part of a customer work system (which may be highly structured or semi-structured).
4) Relying largely on Grönroos's (2011) argument that the co-creation of value is optional in service systems, the RAVC metamodel provides a way to visualize both co-production activities and co-creation of value if co-production or co-creation actually occur within a particular work system.
5) The metamodel includes interactions with other work systems that may affect the service system of interest or a customer work system that creates or co-creates value. Inclusion of other work systems is essential for understanding and analyzing systems of service systems because support or interference by other systems may enable or disable a service system and may enhance or degrade its performance.
6) The metamodel establishes links between resources and activities within a service system and value for customers, thereby providing a view of resources at an operational, service system level. Viewing resources at that level contrasts with enterprise-level discussions of RBV, the resource based view of the firm (Barney 1991; Wernerfelt 1995) in the strategy and management literature. According to the RBV, sustainable competitive advantage is based on controlling and using resources that are valuable, rare, inimitable, and non-substitutable.

When focusing on information systems or information technologies, RBV is usually discussed under the heading of the business value of IT (BVIT), e.g., Bharadwaj 2000; Wade and Hulland 2004; Nevo and Wade 2011)

7) Instead of treating information and technology in general as resources, the RAVC metamodel identifies different types of technological and informational entities. Being more specific about categories of resources providing a useful link to systems analysis and design methods and to sociological discussions of the importance of plans, commitments, conversations, and other information that may never be stored in computerized databases.

**Why would this matter?** The development and use of the RAVC metamodel or something like it has a number of potential benefits. As discussed at length in Alter (2012a), fundamental challenges for service science start with unsatisfying definitions of basic concepts such as service and service system. Regardless of which definition is used, a metamodel of this type can be useful for visualizing how specific definitions of those terms and other service science terms apply to specific situations that are typically considered services in everyday life. That can be done by instantiating specific service systems using the entity types and relationships in the metamodel and examining whether the definitions apply to each example. Since it is likely that some readers will disagree with characterizations in the metamodel, the metamodel's specificity will facilitate debate and could lead to improved or even completely different metamodels that might generate better understandings of service, service systems, and SOSS. In addition, a metamodel at an operational level (rather than just general and often controversial definitions of service-related terms) should be useful for understanding and analyzing existing service systems and for designing improvements or new service systems. Finally, a metamodel for understanding service systems at an operational level is needed to address many of the topics identified in the Call for Papers: understanding and managing service systems that may work together in interactive, automated or semi-automated ways; systems decommissioned, added, revitalized; functionalities added to existing systems; heterogeneous systems of service systems of different age, quality, reliability, and performance; prudent management of emerging service systems risks; difficulty managing SOSSs. The metamodel may help because all of these concerns require ways to identify and visualize important specifics of particular service systems.

## Organization

Since the general rationale of the previous versions has been explained a number of times in previously mentioned publications that include citations, quotations, rationales, and comparisons with ideas from other authors, this paper proceeds to the explanation of the RAVC metamodel as directly as possible. It uses Figure 1 to illustrate the interpretation of basic service science terms that is built into the RAVC metamodel in Figure 2. It discusses the metamodel from top to bottom to make sure that its concepts and relationships are clear. The final section discusses the metamodel's implications.

## BASIC CONCEPTS RELATED TO SERVICE, CUSTOMERS, AND VALUE

Figure 1 illustrates the interpretation of basic concepts related to service, customers, and value that forms the basis of the RAVC metamodel. Details of Figure 1 diverge from some of the foundational premises of service dominant logic (Vargo and Lusch 2004, 2008) and from definitions in other parts of the service science literature (See Alter 2012a, 2013a). The oval in Figure 1 highlights the relationship between service, value, and customer. It says that services are directed toward customers, that service facilitates value for customers, and that customers experience value. In other words, understanding service in any specific situation requires identification of the relevant customers and at least summarization of the types of value that customers perceive.

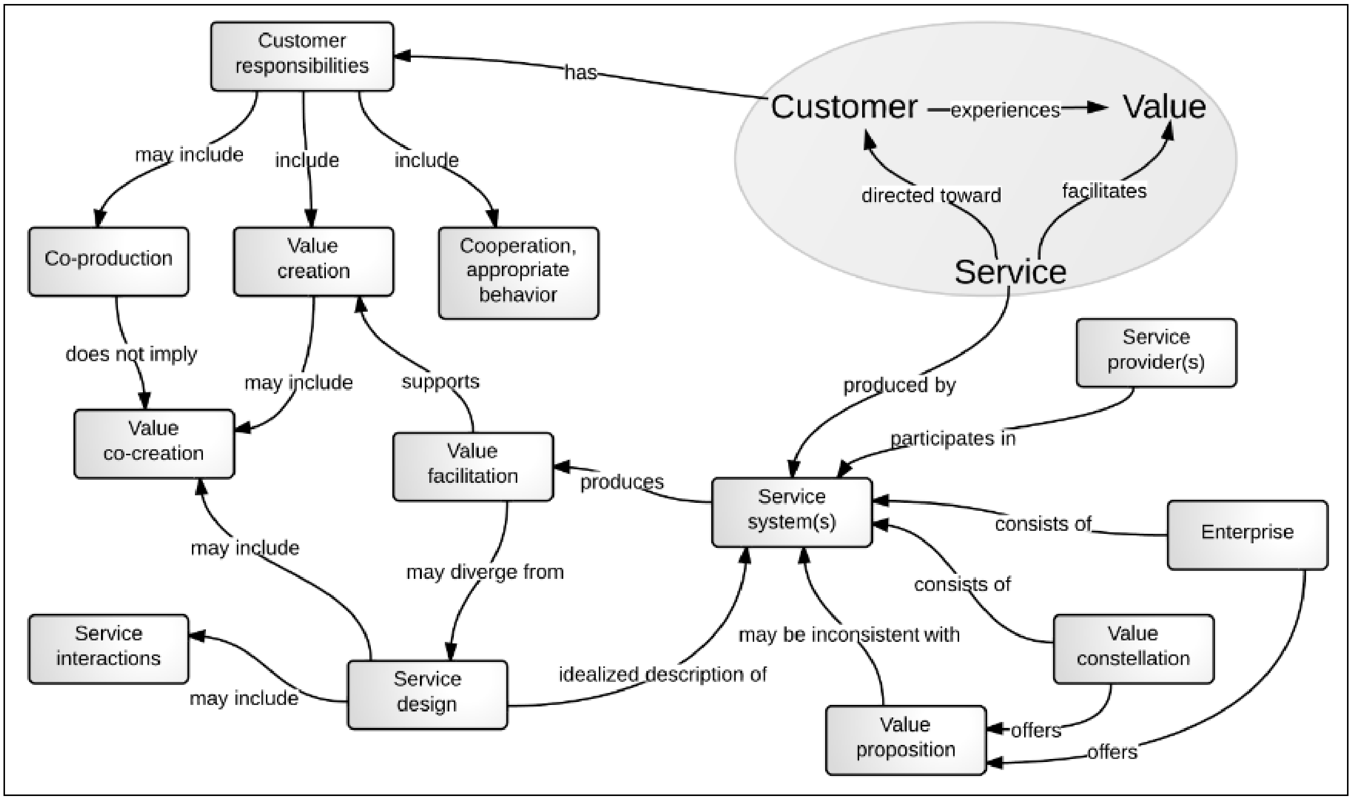


**Figure 1.** Fundamental concepts related to customers, service, and value. (Alter, 2013)

The other main ideas expressed by Figure 1 are as follows:

- Services are acts performed for the benefit of others. In some instances, the service is viewed as an act or set of acts, such as a teacher helping a student or a restaurant preparing and serving a meal. In other instances, the service is viewed as the outcome of many acts, some of which may not be perceived at all, such as guaranteeing a loan, producing software, supplying electricity, or maintaining public safety.
- A more general definition that also covers totally automated services replaces the word *others* with *other entities*, whereby services are acts performed for other entities (proposed by Alter (2012a) after reviewing other definitions in the literature). By this definition, and consistent with service-dominant logic, almost any economic activity can be viewed as a service, regardless of whether it is directed at external customers or internal customers. The proposed definition of service is most consistent with the way Grönroos (2011, p. 285) defines service as "value-creating support to another party's practices." As suggested by Normann (2001), this support may either relieve customers from taking on some task or enable them to do something that otherwise would not be possible to accomplish or would be accomplished less efficiently or effectively."

- Figure 1 represents customers as direct recipients or beneficiaries of the services that a service system is designed to produce, i.e., not intermediate customers of previous steps within the service system of interest and often not paying customers. Customers may be internal customers who receive and use services that are directed internally within an enterprise. They may be external customers who receive and use services that are directed at people or things outside of the enterprise. Internal and external customers should be treated symmetrically in regard to understanding and analyzing services. Different groups of internal and external customers should be recognized because the vague and nonspecific concept of "the customer" is insufficient for service situations involving multiple customer groups and other stakeholders with conflicting perceptions and priorities related to whatever a service system produces.
- Services that are produced systematically (i.e., are designed) are produced by service systems, a type of work system. A work system is a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce specific products/services for specific internal and/or external customers (Alter 2006, 2008, 2013b). Special cases of work systems include information systems (devoted to processing information), service systems (devoted to producing products/services for others), supply chains (interorganizational work systems that provide resources for end customers), projects (temporary work systems designed to produce certain deliverables and then go out of existence), self-service work systems (whose customers are their primary participants) and totally automated work systems (set up by participants in other work systems but having no participants of their own). Almost all work systems are service systems. The exceptions are work systems that are not directed at others, e.g., an individual's personal work system for pursuing a personal project or hobby.
- Economic enterprises and value constellations (Normann and Ramirez 1994) consist of service systems.
- Service customers are customers of service systems.
- Service systems produce value facilitation (Grönroos 2011), which supports value creation by customers. A service system is a work system that produces services. Service providers are service system participants who perform roles directed at facilitating value for customers. Customers also may be service system participants because they often perform some of the work within a service system during activities involving co-production.
- Customer responsibilities may include co-production, often include appropriate behavior and cooperation (e.g., passenger on an airplane), and almost always include value creation.
- In relation to Figure 1, value is a property of a service or thing summarizing its usefulness and importance to a particular person or group. This is consistent with foundational premise #10 in a revised version of service dominant logic, "value is always uniquely and phenomenologically determined by the beneficiary." (Vargo and Lusch, 2008). It is also consistent with an observation in Ramirez (1999) that "the value of offerings is established only partially in terms of the activity which the supplier has poured into these [offerings]." Value to the customer includes "labor saving value, whereby customers do not have to carry out the activities 'crystallized' in the acquisition," and enabling value, which is related to "the enhanced ease, productivity, safety, elegance, and/or effectiveness" in the acquirer's value-creating actions. Defining value in relation to value-in-use and importance implies that something with very low exchange value may have high personal value to customers of a service. Notice that seeing value in relation to what individuals care about differs from many other approaches to value, such as economic and marketing definitions related to actual or estimated exchange value, and

definitions from operations management related to "value added" and "value streams." Notice, for example, that "value added" is fundamentally about identifying the resources consumed by specific activities within a service system. That may be unrelated to value for the customer.

- Value creation may or may not include value co-creation, i.e., value co-creation is optional (Grönroos 2011), contrary to assertions that value co-creation is inherent in services (e.g., Vargo and Lusch 2008). Instead, value creation by customers may be geographically and temporally distant from service activities performed by a service provider. Similarly, value creation may not be directly related to co-production of services because co-production activities may help the provider and may not be directly related to creating value for customers. In practice, the important point is not whether value is automatically co-created or whether value is facilitated and value co-creation is optional. For designing and evaluating services, the important question is finding cost-effective/ profitable ways to facilitate value for customers. Just saying that value is co-created provides little guidance for analyzing or designing services.
- Service design may or may not include value co-creation and service interactions, contrary to some generalizations that service interactions are the essence of service. The actual operation of a service system and the value facilitation that it produces for specific customers may diverge from its design in various ways. The sources of divergence include behavioral discretion, incomplete specifications, unexpected exceptions, other contingencies, workarounds, adaptations, and other conditions or occurrences.
- There are often inconsistencies between value propositions, service system design, and value facilitation as it actually occurs in particular service systems.

## THE RAVC METAMODEL

The RAVC metamodel in Figure 2 expresses an operational perspective (rather than an enterprise, marketing, or economic exchange perspective) on relationships between a large number of concepts that are important for understanding service systems individually and in the context of systems of service systems. In effect, it operationalizes the perspective in Figure 1 by including all of the extensions of previous metamodels that were mentioned in the introduction. The result is a unified perspective related to the operation of service systems within systems of service systems, including linkage between resources for action and value for customers.

The many concepts in the metamodel are best understood in relation to the other concepts in the metamodel. Accordingly, the following explanation starts at the top and proceeds toward the bottom. It discusses specific entity types, groups of entity types, and relationships between entity types. In some instances a relatively familiar entity type is introduced in relation to another entity type and is explained in more depth several paragraphs later. Terms are *italicized* in the following explanation as a reminder to see where those terms appear in the metamodel.

As noted at the bottom of Figure 2, most of the entity types in Figure 2 have numerous attributes that cannot be displayed in a one-page representation, such as multiple goals, characteristics, metrics, and relevant principles. Those attributes could be included in a computerized representation that could be used to display attributes when a user of the metamodel needs to see them. For example, an informational entity's attributes related to size, form, coding scheme (if any), precision, and accuracy depend on the type of informational entity (e.g., transaction record or document) and are important for some purposes and unimportant for other purposes).

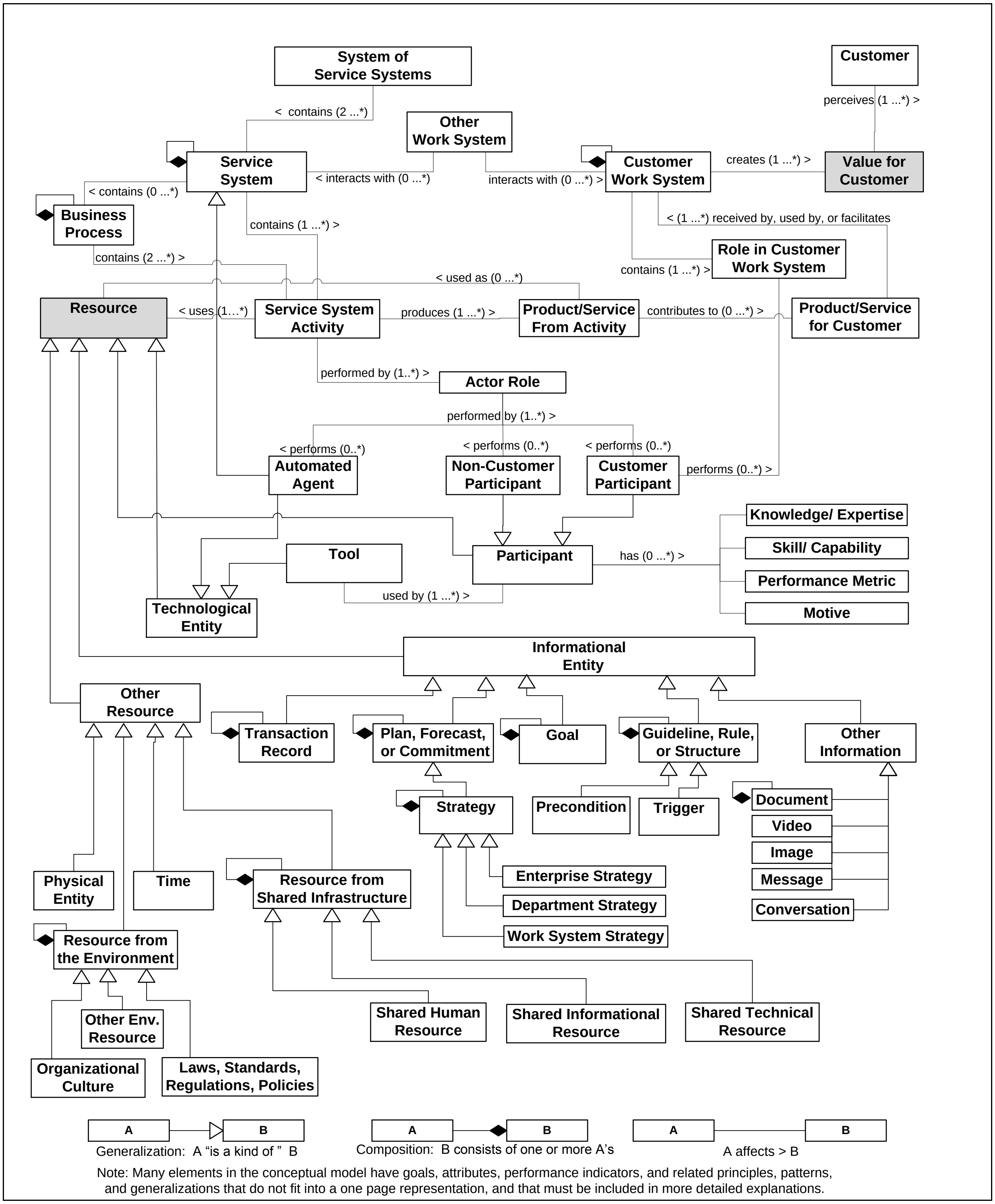


**Figure 2**. The RAVC metamodel

**Service system**. A *service system* is a type of work system (defined previously).

**System of service systems**. A *system of service systems* (SOSS) consists of *service systems* whose individual operation and purposeful interactions produce *products/services* for customers of the SOSS. Those customers may be customers of several systems within the SOSS. While the metamodel notes that specific service systems may be components of an SOSS, it treats customers as customers of specific service systems rather than of the entire SOSS.

**Activity, business process**. A *service system* must contain at least one activity because otherwise it doesn't do anything. An activity within a service system is called a *service system activity* to differentiate that activity from an activity performed in the customer's world, typically as part of a *customer work system*. A *service system* may or may not contain a *business process*. It contains a *business process* if specific sets of two or more *service system activities* are coupled tightly enough (through sequence, interactions, and boundary objects) that they should be considered a *business process*.

**Service system activity, customer work system.** The metamodel refers specifically to a *service system activity* that occurs within the *service system* and a *customer work system* that performs activities within the customer's realm. For the sake of simplicity, the metamodel does not mention the relatively rare customer activities that not associated with *customer work system*. Thus, activities within a customer's realm are assumed to occur within a customer work system

**Service system activity, resource, product/service.** The term product/service is used to denote something that an activity produces. A *service system activity* uses one or more *resources* to produce one or more product/services. It must use *resources* because it cannot produce something from nothing. It must produce at least one product/service because otherwise it would not accomplish anything. The metamodel uses the term product/service and does not distinguish between products and services because many activities produce things that include some characteristics associated with products and some characteristics associated with services, as is explained in Alter (2012a).

The metamodel distinguishes between two types of product/services. *Product/service from activity* is whatever a specific service activity produces. This may be a *resource* for subsequent *service system activities* within the *service system* or may contribute to a *product/service for customer* that is received or used by a *customer work system* or that facilitates the operation of a *customer work system*. The previously mentioned examples of guaranteeing a loan, producing software, supplying electricity, or maintaining public safety illustrate that a *product/service for customer* may be an accumulated outcome of multiple product/services produced by *service system activities*.

**Service system, customer work system, other work system**. The metamodel's distinction between *service system* and *customer work system* is included to highlight definitional issues related to concepts such as value, value co-creation, and co-production of service. Co-production occurs when a *customer participant* plays an *actor role* within a *service system activity* (as explained below). Co-creation occurs when value creating activities in a *customer work system* coincide or overlap with *service system activities*. Since *service system* is a type of work system and since almost all work systems are service systems, for purposes of explanation it is unnecessary to repeat the same concepts for the *customer work system*.

The concept *other work system* is included because the analysis, design, and management of any service system needs to consider the impact of interactions with work systems other than that *service system*. While the importance of interactions outside of the *service system* may seem obvious, including *other work system* in the metamodel is worthwhile because managing any *service system* requires attention to interactions with *other work systems*. Furthermore, attention to interactions is especially important in managing *systems of service systems* due to the possible occurrence of many types of expected and unexpected interactions.

**Value for a customer**. With relatively few exceptions, customers create value for themselves through one or more customer activities in a *customer work system*. A *product/services for customer* facilitates that value creation. In cases that are rare and therefore are not included in the metamodel, a *service system* may provide *value for a customer* without any customer activity. An example of that type is an individual receiving value from the safety afforded by community police service system despite doing nothing related to that system and possibly being largely unaware that it exists. Another example is value from automatic software updates that occur without a customer's awareness.

**Resources, activities, value for customers**. One of the metamodel's goals is to create a link between *resources, service system activities* within a *service system* and *value for (its) customers*. The metamodel identifies different types of resources used by activities in a *service system*. The link between *resources* and *value for customers* follows a simple path. A *service system activity* produces one or more *product/services from activity*. A *product/service from activity* may serve as a *resource* for another *service system activity* within the same *service system*, as happens in an assembly line when the output of step 5 is a resource for step 6. A *product/service from activity* also may be received and used by a *customer work system* that produces *value for customer.* While the same types of resources and other concepts are relevant to a *customer work system*, the metamodel does not repeat those ideas for that system.

**Actor role.** A *service system activity* is performed by one or more *actor roles* including *non-customer participant*, *customer participant*, and *automated agent*. A *non-customer participant* is an agent of the *service system*. That role participates in activities for the purpose of contributing to *products/services* that eventually lead to *value for customers*. A *customer participant* is an agent of one or more *customer work systems*. Where included in a *service system*, that role participates in at least one *service system activity* that produces *products/services for customers* or for subsequent use by other *service system activities*. In some cases *customer participants* are also end customers who receive those *products/services from activity* and the related *value for customer*, e.g., a person who receives medical services or a person who attends a concert. In other cases, they are customer representatives who participate in activities in a *service system* in order to facilitate value for others who are end customers. An example is a customer firm's representative in a custom software development service system that will produce software for that firm. The representative may never see or use the *products/services for customer* that are being produced.

**Automated agent**. An *automated agent* is a software entity that operates autonomously after it is launched by a *service system activity, customer activity,* or *other work system*. An automated agent is actually a type of service system. Since automated agents are service systems, they can be described and analyzed in terms of almost all of the same entity types and relationships in the metamodel. The only difference is that automated agents have no human *participants*. Someone who creates an automated agent is not a participant in the automated agent, just as someone who designs and implements a sociotechnical service system such as an information system often does not participate in its operation.

**Co-production, co-creation of value.** Co-production and co-creation do not appear explicitly in the metamodel but can be inferred from any particular instantiation of the metamodel. Co-production occurs when one or more *service system activities* have *customer participants.* Thus it is possible to say that there is some co-production in a *service system* in which one of 30 *service system activities* involves at least one *customer participant.* Another *service system* may have a higher degree of co-production because 20 of its 30 *service system activities* involve a *customer participant.*

Co-production does not imply co-creation of value because an instance of co-production may or may not coincide or overlap with activities within a value creating *customer work system*. A *customer participant* sometimes plays an *actor role* in a *service system activity* that is not part of a significant *customer work system*, as when a *customer participant* calls a complaint handling *service system* to complain about a problem. In other cases, *service system activities* within a *service system* may coincide or overlap with activities in a *customer work system*, as when employees of an outsourcing firm perform some of the customer activities in a *customer work system*. One of the management complexities in that type of situation is that the *service system* and *customer work system* have some activities that overlap and some that don't overlap and may have different incentives and rationales.

Co-creation of value occurs when *service system activities* coincide or overlap with value creating activities within a customer work system. For example, a step in a medical exam in which a doctor listens carefully to a patient may be viewed as co-creation of value if the patient appreciates the conversation and/or if it contributes to the medical treatment. An alternative view sometimes implied by service researchers is that co-creation of value occurs whether or not provider and customer activities coincide (e.g., when a manufacturer produces a basketball that a customer uses later). The usefulness of that view is questionable because it basically states the obvious point that economic activities are directed toward producing things or conditions that someone else will value.

Implementing, requesting, or initializing a service system often is not an instance of co-production within that system. For example, someone who implements or initiates a lawn mowing system or a policing system may not be involved in any operational activities within that service system, just as a programmer who plays a key role in a service system of producing software often is not involved in a service system that uses the software routinely.

**Resource.** Resources include human *participants*, *informational resources*, *technological resources*, and *other resources*, each of which will be explained next.

**Participant**. A *participant* in a *service system* plays one or more *actor roles*, either as a *non-customer participant* or *customer participant*. The term *participant* emphasizes that for analyzing and managing *service systems*, it is more important to see people as human *participants* rather than as users of technology. Those who are users of technology have a "uses" relationship with a *tool* as part of an *actor role* within a *service system activity*. Analysis, design, and management of service systems should include important attributes of participants such as *knowledge/expertise, skill/capability, performance metrics*, and *motives*.

**Technological entity**. A *technological entity* may be a *tool* or an *automated agent*. Service system *participants* use *tools* while performing *actor roles* within a *service system activity*. *Automated agents* are computerized entities that perform activities autonomously after being launched by specific activities or conditions. An *automated agent* is a type of *service system* because it is designed to perform one or more *service system activities*. Treatment of *automated agents* as *service systems* provides a symmetrical way to decompose sociotechnical *service systems* during systems analysis and design. The decomposition process eventually isolates *automated agents* that can be decomposed further using the same approach until there is no further value in the successive decomposition. This decomposition may prove useful in providing a path from sociotechnical descriptions to service-oriented architectures.

**Informational entity**. The metamodel identifies many types of *informational entities* including *transaction record*; *plan, forecast, or commitment* (including *strategy*); *goal*; *guideline, rule, or structure* (including *precondition* and *trigger*); and *other information* (including *document, video, image, conversation*, or *message*). The purpose of identifying these types of information is to make it less likely that analysts or managers will focus on computerized transaction information and will not pay as much attention to other important information such as *plans, forecasts, commitments, goals*, and so on. While it is possible to treat *document, conversation,* or *message* as an attribute of a particular *plan, forecast, commitment,* or *goal* (e.g., a forecast that appears in a document), the existence of many important *documents, conversations,* and *messages* that express other types of information led to the design choice of including those types of *informational entities* under a blanket category of *other information*. Treating all of those types of information as resources is a reminder that excessive systematization of service systems with human participants may result in worse performance if it destroys social information that doesn't fit into transaction databases or formal rule systems.

The metamodel's identification of specific types of informational resources was motivated by finding references to "resources for action" related to situated action and communities of practice. For example, Schmidt (1997, p. 142) cites Suchman's (1987, p. 52) statement that "plans are resources for situated action, but do not in any strong sense determine its course." The image of "resources for action" provided a fruitful direction for expanding the previous versions of the metamodel by bringing resources to the forefront. Other informational entities identified previously as resources for action include knowledge (Gherardi 2010), time (Torre 2007), and instructions (Sherry et al. 2004). The computer science literature provides a very different approach to resources through the i* framework (Yu 1997) and GRL ontology (University of Toronto 2013), which includes intentional elements (goal, task, softgoal, belief, and resource), intentional relationships (means-ends, decomposition, contribution, correlation, and dependency) and actors.

**Other resources**. The category *other resource* provides a place for additional resources that should not be overlooked, including *time*, *physical entity*, *resource from the environment*, and *resource from shared infrastructure*. *Physical things* that might or might not be viewed as technological entities include offices, buildings, and automobiles. *Resources from the environment* include things such as the organization's culture, which may enable activities that could not otherwise occur. Other resources from the environment include organizational policies and procedures, laws and regulations, sociopolitical factors, competitive factors, and other factors that affect the work system but are viewed as existing outside of it. *Resources from shared infrastructure* include *shared human, informational,* and *technological resources* that are shared with other service systems. Whether or not those resources would be viewed as part of the service system or part of the organization's infrastructure is a matter of interpretation and is not of fundamental importance in using the metamodel. The fundamental issue is that aspects of the surrounding environment and/or the relevant shared infrastructure should be considered in any realistic analysis or design of a service system in an organization and in an SOSS.

## LOCATION OF SERVICE SCIENCE CONCEPTS IN THE METAMODEL

The metamodel's operational view of service systems treats various service science concepts quite differently. It includes some of them explicitly, supports inferences about other concepts, and omits other service science concepts altogether.

**Service**. The term service appears in five entity types: *service system activity, product/service from activity, product/service for customer, service system,* and *system of service systems*. Service systems are viewed as operational work systems whose outputs are called product/services because they often combine characteristics associated with products and other characteristics associated with services. That choice of terminology is based on the assumption that for purposes of analysis, design, and management of operational systems, features and characteristics of whatever is produced are much more important than yes/no distinctions between products and services.

**Customer**. The term customer appears in five entity types in the metamodel: *customer, value for customer, customer work system, customer participant,* and *non-customer participant*. As explained previously, activities in a *customer work system* may or may not coincide with a *service system activity* performed by a *customer participant*.

**Customer experience, customer interaction**. The metamodel addresses mechanical aspects of customer experiences and customer interactions by modeling the relationship between *service systems* and *value for customers* via *service system activi*ties*, actor roles, product/services from activity,* and so on. The separation between *service system activity,* and *customer work system* assumes that that customer experiences and customer interactions with a service system may be important in situations where there is a great deal of co-production or co-creation of value and unimportant in other situations where customers may have little awareness or concern about specific service systems that serve them.

**Value to customer, value proposition**. *Value to customer* is an important concept in the metamodel because one of its purposes is to provide a link between *resources, service system activities,* and *value to customers*. The concept of value proposition does not appear in the metamodel because it is a promise or belief rather than operational concept and because it often applies at an enterprise level rather than a service system level. Value proposition could be treated as a service system attribute (like other attributes not shown in Figure 2) that can be used in evaluating customer satisfaction and other aspects of performance.

**Co-production, co-creation of value**. These concepts are not included explicitly in the metamodel but can be inferred from specific instantiations of the metamodel. Co-production occurs where *customer participants* play *actor roles* in one or more *service system activities* within a *service system*. Co-creation of value occurs where one or more activities in a *customer work system* that generates *value for a customer* coincide with one or more *service system activities*.

**Resources**. The metamodel identifies different types of resources in each of four categories: *human participants, informational resources, technological resources,* and *other resources*. It contains both operant and operand resources that are mentioned in service dominant logic (Vargo and Lusch 2004, 2008), but does not emphasize that distinction because a service system participant can be a resource of both types (e.g., a physician's patient who performs some of the activities in a medical service system and is acted upon by physicians and other participants within that system). The metamodel's treatment of human participants as resources that are used by activities may seem counterintuitive and also may seem unnecessarily mechanistic to researchers who see communities of practice and human interests as the focus of design. The metamodel treats participants in this way in order to treat people, information, technology, and other resources as symmetrically as possible. That symmetry is potentially useful when decomposing service systems during analysis and design. Striving for that type of symmetry in the metamodel's structure does not imply ignoring uniquely human capabilities, sensibilities, and related concerns. Finally, as mentioned earlier, most of the resources in the metamodel are at the operational level and not at the enterprise level that is the focus of the resource based view (RBV) of the enterprise. At the metamodel's level of analysis, the question is not about what resources are the basis of competitive advantage, but rather about what is used and produced by *service system activities*.

**Competition, competitive advantage, economic exchange**. These concepts are quite important in service dominant logic. They are not mentioned in the metamodel because it focuses on operational service systems rather than the nature of competition and economic exchange.

**Service oriented architecture**. Basic service orientation can be modeled using the metamodel because a request or a precondition is a resource that triggers the first activity in a service system, e.g., in a web service. It would be interesting to test or extend the metamodel by trying to apply it to service oriented architecture in a broader way.

## THE METAMODEL AS A LENS FOR TOPICS RELATED TO SYSTEMS OF SERVICE SYSTEMS

The Call for Papers for this workshop noted a number concerns about SOSS that are widely recognized without using a metamodel. Such concerns include the following:

- SOSS are complicated and difficult to manage.
- The behavior of an SOSS is often difficult to predict because of the many interactions between systems within the SOSS and interactions with the surrounding environment.
- A problem in one system within an SOSS can propagate to other systems and can affect operational results or even cause system failure, as has happened in recent years in national electric grids and in "flash crashes" of highly automated stock exchanges.
- Issues related to visibility and trust are exacerbated when different systems with an SOSS are owned by different enterprises that have their own goals, culture, and work practices.
- Change is difficult to manage in systems of systems in general, and even more difficult if individual systems are owned by enterprises with different goals, cultures, and interests.

This concluding section builds on the explanation of the RAVC metamodel by summarizing ways in which it might illuminate important topics related to analyzing, designing, and managing an SOSS. The SOSS might be a sociotechnical system such as a supply chain, surgical facility, or water system, or might be a totally automated system such as a complex web site, a high frequency stock trading system, or an IT infrastructure based on service oriented architecture. Ideally, the metamodel would help in going further than just repeating the common generalizations mentioned above. The following are areas where the metamodel's specificity might help designers, analysts, managers, and researchers think about issues related to SOSS:

**What is really meant by SOSS?** While generalizations about SOSS such as those above are easy to state, it is far from obvious how to go further in clarifying exactly what SOSS means, especially since there is disagreement about what *service system* means, as explained in Alter (2012a). The metamodel addresses the need for clarity by elaborating and clarifying a particular view of service and service systems. Other metamodels, possibly based on other definitions of service and service system, might address the need for clarity more effectively. Regardless, Figure 2 is a step along that path because the relative merits of this metamodel and other metamodels might lead to greater clarity about the implications of different definitions of SOSS.

**Documentation of an SOSS**. The multiplicity of entity types and relationships in the metamodel illustrates the overwhelming nature of producing detailed documentation of an SOSS. Producing a complete description of each system within an SOSS requires a great deal of work even when focusing solely on those systems in isolation. Clarifying their direct and indirect interactions requires even more work. An obvious guideline for an issue-driven one-time analysis is to choose the level of aggregation that is appropriate for the purposes at hand.

A more ambitious approach would try to articulate methods and paths for zooming in or drilling down between highly aggregated big picture documentation and more detailed documentation of any part of an SOSS. Imagine using something like the zoom in/ zoom out capability on Google Maps except that different sliders might be used for zooming between layers of aggregation using conceptually distinct paths that emphasize different topics. Operating somewhat in the spirit of aspect systems (Land and Proper, 2007) and aspect-oriented programming (Elrad et al., 2007), it might be useful to examine any of the following: specific service systems at different levels of detail, interactions between service systems at different levels of detail, resources used by service systems (going from activity-specific resources to aggregated resources of the SOSS), overlaps between service systems revealed by their use of the same resources, accumulation of value for customers (going from activity-related value to value from the entire SOSS), and so on. The highly aggregated summaries of an SOSS might be produced using approaches including the DEMO method (Dietz 2006, 2013), various business architecture methods such as those discussed in Glissmann and Sanz (2009), various business model summaries (e.g., Chesbrough 2010) or other enterprise architecture methods. The main processes or modules from those aggregated views might be treated as service systems within the metamodel, with some additional work to make sure that the main interactions are specified. Each of the service systems could be subdivided or decomposed further using a similar method, thereby providing at least three linked levels of detail for different kinds of inquiries or analysis. Demonstrating the practicality of that approach would require detailed specification of realistic examples, which involves the same level of effort that is required for saying almost anything about SOSS beyond the broad generalizations mentioned above.

**Visibility and vigilance in an SOSS**. Regardless of whether an SOSS crosses enterprises or exists within an enterprise, the interdependence of its service systems calls for appropriate levels of visibility and vigilance to ensure that each service system will play its part. Managers of entire SOSSs and of service systems within an SOSS need to decide how much they can trust the other service systems and where they need visibility of the ongoing operation of those systems. For example, managers in supply chains often complain that they lack visibility of what is coming their way and that better visibility would help them manage more effectively. The metamodel's structure might help in understanding what types of visibility and vigilance are important to whom in managing an SOSS or a service system within an SOSS. It might also help managers of service systems within an SOSS in deciding what they should make visible in order to work effectively with SOSS partners and what they should hide based on their own interests.

**Loose coupling or tight coupling**. The metamodel might help in thinking about the nature and impacts of loose and tight coupling (Orton and Weick 1990) in specific SOSS situations. Instantiations of the metamodel for different SOSSs could be analyzed to explore the extent to which the operation of one service system is guided by information about the status and operation of other service systems (tighter coupling), rather than just messages or outputs of other service systems (looser coupling). In turn, that could lead to richer characterization of the rationale for looser or tighter coupling, especially in sociotechnical service systems where managers often play active roles in maintaining operational performance.

**Emergent properties**. Since an SOSS is a system in its own right, it has some properties that are not properties of the individual service systems that it contains. In addition to guiding the identification of service systems within an SOSS, the metamodel might help in identifying their emergent properties, and understanding how those emergent properties roll up into the emergent properties of the larger system. An initial approach is to identify and compare emergent properties of an SOSS, of service systems it contains, and of subsystems of those systems.

**Resource availability and resource requirements**. The metamodel provides a scaffolding for specifying and analyzing the use of particular resources by service systems within an SOSS. That type of lens might lead to better understandings of internal resource conflicts, overlaps, and shortages along with excess resources within the SOSS. For both management and research it might provide more useful information than vague comments about the advantages of having superior human capital or superior computer network capability.

**System interactions, interference, and points of failure**. Even a relatively small flaw in the design of a single service system can have major consequences for an entire SOSS, e.g., locating emergency generators in the basements of buildings that may be flooded. The metamodel's structure provides an outline for searching for direct and indirect mutual impacts of *service systems* within the SOSS, *customer work systems*, and *other work systems* that are sufficiently relevant to be included in that category. The direct mutual impacts are related to *resources* used by *service system activitie*s, *products/services for customers*, and interactions with *other work systems*. Other interactions are less direct, such as controlling resources needed by other service systems or operating in a way that interferes directly or indirectly with another service system. While it is unlikely that all relevant interactions and types of interference can be anticipated, a detailed metamodel would help in finding more of those potential problems.

**Dealing with change**. A change in any part of a system within an SOSS may reverberate to other systems and may affect their interactions. The metamodel provides a way to express the change and trace some of its reverberations through changes in *products/services*, *resource* availability, interactions, and so on. For example, use of the metamodel to describe service system outsourcing would help in tracing changes across the entire SOSS. Immediate questions would include whether the *service system activities* would change when the *participants* changed and what changes would occur to assure that the outsourced service system would fully achieve its goals within the SOSS. Perhaps only part of the service system would be outsourced. Regardless, the metamodel would provide a way to describe and analyze the changes.

**Agent based modeling.** The structure of the metamodel provides a starting point for agent based modeling of an existing or proposed SOSS. This would require a metamodel instantiation for the SOSS linked to a simulation package that supports agent based modeling. The initial conditions would be described as the state of each entity. Demand would come from the environment and would trigger the metamodel to action.

## CONCLUSION

The purpose of the metamodel is to explain relationships between concepts rather than to serve as a formal basis for programming. This paper's remix of concepts involved a number of interpretations that touch controversial topics in several disciplines. While this paper recognized some of those controversies, its interpretations of concepts were always for the purpose of establishing a richer way to describe and understand IT-reliant systems in organizations. By design, this approach integrates many concepts that normally are not emphasized in the IS discipline or that are treated in a different way or at a different level of granularity.

This paper explained a metamodel that extends previous metamodels in a number of useful ways described at the outset. The next steps in this research require further bench testing of the metamodel with toy examples and then development of complete instantiations to test its usefulness. At minimum, it provides a point of comparison with other models and metamodels that may be helpful in analyzing, designing, implementing and managing an SOSS.

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