The Resource-Service-System Model for Service Science

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Abstract. Service Science is the interdisciplinary academic field that studies service systems. A challenge for Service Science is the development of abstractions, models, vocabularies, and measures that support service systems research. This paper proposes the Resource-Service-System model as a conceptual model for Service Science that emphasizes that, in an economic context, service systems interact through the exchange of service for service in a mutually beneficial manner. This new model is adapted from the REA model of economic exchange by analyzing REA from the perspective of the Service-Dominant Logic economic worldview, which has been proposed as the philosophical foundation of Service Science.

1 Introduction

Service Science is the emerging academic field that studies service systems in order to discover underlying principles that can inform service innovation and guide the design, improvement, and scaling of service systems [1]. As a distinct interdisciplinary field, Service Science needs an idiosyncratic and unifying paradigm to provide identity and discriminate it from its many contributing but separate service research disciplines [2]. Service-Dominant Logic (SDL) [3] has been proposed as a philosophical foundation of Service Science that "provides just the right perspective, vocabulary, and assumptions on which to build a theory of service systems, their configurations, and their modes of interaction" [4, p. 18].

SDL is a worldview that sees all economic activity as service exchanges between service systems (which can be individuals or groups of individuals like families, firms, and nations [5]). In SDL, service is defined as the application of competences by one service system for the benefit of another service system. In the traditional economic worldview, referred to as Goods-Dominant Logic (GDL) [6], a service is seen as a second-class product that suffers from shortcomings like intangibility, heterogeneity, inseparability, and perishability. In GDL, services are to the best possible extent, as far as allowed by their shortcomings, treated as any other kind of product (e.g., goods, rights). GDL considers services as transferable *resources* that have a nominal value that is determined through their exchange for other resources (usually money). In contrast, SDL sees a service as a collaborative *process* in which each party brings in or makes accessible its unique resources. In SDL, it is the provision of resources by one party and their acting upon the resources of another party that creates

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real value with and for that other party (i.e., the service beneficiary). Economic rationale dictates that service systems do not interact to create value for just one of them. They interact such that value is created for both of them. In other words, service exchange is the economic motive for service systems to engage in interactions with other service systems because it is through service exchange that service systems can improve their state.

Service Science needs modelling and simulation tools that help studying service systems. Current challenges for Service Science include the formal representation and measurement of work in service systems [7] and the development of a shared vocabulary to describe service systems [8]. This paper aims to contribute to Service Science by proposing a conceptual model of economic exchange in SDL. The model is derived from the *Resource-Event-Agent* (REA) model of economic exchange [9], which is firmly grounded in well-established accounting and business process theories. REA focuses on the effect of economic exchanges on the resources controlled by the legal and natural persons that participate in the exchanges. The new model, which we call the *Resource-Service-System* (RSS) model, is constructed based on an SDL interpretation of REA, using terms and definitions taken from SDL literature and two genuine Service Science research contributions: the system theoretic definition of service system provided in [8] and the *Interact-Serve-Propose-Agree-Realize* (ISPAR) model of service system interaction presented in [10].

Section 2 presents and illustrates the RSS model. Section 3 evaluates the model by comparing it to existing models. Section 4 discusses the potential use of the model in Service Science and suggests future research.

2 The RSS Model

Fig. 1(a) shows the REA model of economic exchange. An *economic resource* is a valuable *good*, *right*, or *service* that is presently under the identifiable *control* of an *economic agent*. An economic resource is under the control of an economic agent if that person owns the resource or is otherwise able to derive economic benefit from it. If two economic agents desire to obtain control of one or more economic resources controlled by the other agent, then both agents may wish to engage as trading partners in an economic exchange, which is a business transaction that transfers the control of the resources between the agents. A transfer of control of (a) resource(s) from one agent to another agent is modelled as an *economic event* in which the concerned resource(s) (is)/(are) identified by a *stockflow* relation and the agents participate in *provider* and *receiver* roles. Economic reciprocity in exchanges is modelled through the *duality* relation between economic events and *requiting events* (often payments), in which the provider and receiver roles of the involved agents are switched.

Although REA is a conceptual model of economic exchange, it is not a model of service exchange in SDL as services are seen as economic resources. Consequently, control of services can be transferred from a provider to a receiver. Instead of co-creating value, the provider is assumed to ‘produce’ the services (i.e., creates value) and the receiver is assumed to ‘consume’ them (i.e., destroys value). Further, to model the transfer of a service, an economic event is needed, e.g., a service transfer, provision, or delivery event. For instance, from a GDL perspective, a garage and a car owner can exchange a car oil change service for money. A REA model of this exchange (Fig. 1(b)) would identify, apart from the oil change service economic resource, an economic event (e.g., oil change service transfer) that transfers the control of the service from the garage to the car owner, meaning that the car owner consumes the oil change service produced by the garage. In return, the car owner pays the garage, causing a flow of money from car owner to garage. Payment is the requiting event of the service transfer. Fig. 1(b) further shows that a REA model allows representing the resource component structure of a service (via the *composition* relation). The car oil change service is composed of oil change competences (i.e., knowledge and skills) embodied in a car mechanic and various other resources (e.g., garage tools, a garage pit, and a quantity of motor oil) used as appliances to convey these competences to the service target (i.e., the car).

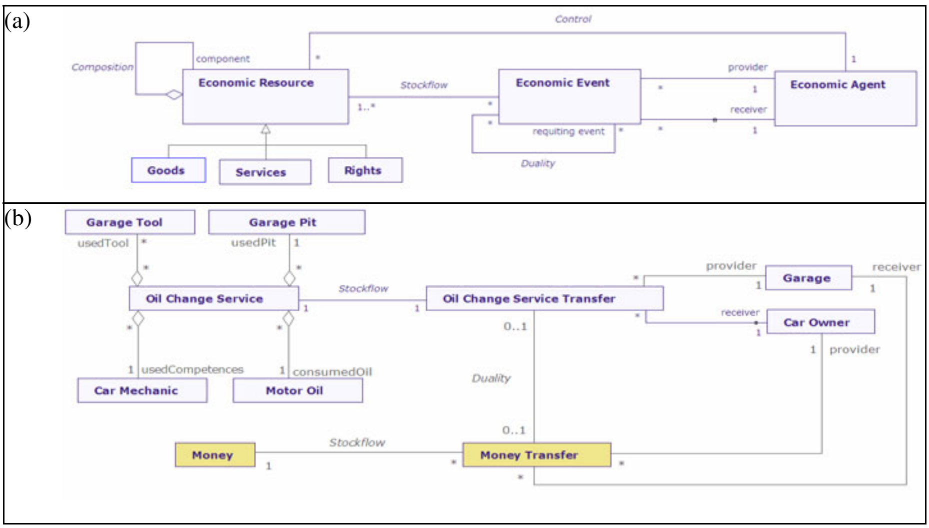

Fig. 1. (a) REA model of economic exchange; (b) exchange of car oil change service for money

In SDL, service is a process and not a resource. REA can provide a conceptual basis for a model of economic exchange in SDL by classifying service as economic event instead of economic resource. Support for this position is found in the ontological analysis of service using the DOLCE upper-level ontology presented in [11], where it is concluded that "it seems legitimate to assume that goods are objects (endurants, in DOLCE's terms), while services are events (perdurants)" [11, s.p.].

Fig. 2(a) shows our SDL interpretation of the REA model in Fig. 1(a). The model is obtained by replacing in Fig. 1(a) economic event by *service*. Like REA economic resources, a *resource* in SDL is something of value under the control of a legal or natural person. If economic exchanges are service exchanges then the persons controlling resources are service systems. The notion of service system is given a system theoretic definition in [8], the main element of which is that a service system is a configuration of resources that is an open system (1) capable of improving the state of another system through sharing or applying its resources (i.e., the other system

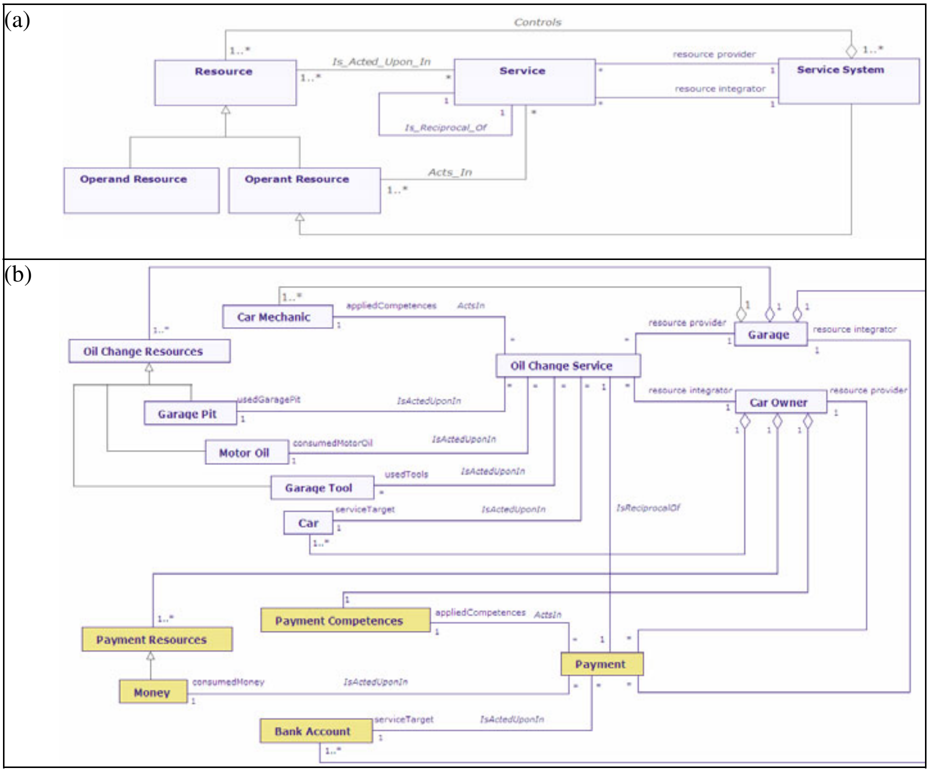

Fig. 2. (a) RSS model of service exchange; (b) exchange of car oil change service for payment

determines and agrees that the interaction has value), and (2) capable of improving its own state by acquiring external resources (i.e., the system itself sees value in its interaction with other systems). Therefore, economic agent is replaced by *service system*. As shown in Fig. 2(a) by the *controls* aggregation relation, a service system is an aggregate (or configuration) of resources that are controlled by the system.

A service is the acting of one or more operant resources on one or more other resources (operand, but possibly also operant) [8]. The distinction between operant and operand resources is a key feature of SDL [3]. Operand resources are passive resources that require action to make them valuable, whereas operant resources are active resources that embody competences (i.e., knowledge and skills) and that can act on other resources to make them valuable. According to [12], this distinction can enrich the conceptual foundation of Service Science as service systems are driven by operant resources rather than operand resources. Therefore, *resource* is specialized into *operant resource* and *operand resource* (instead of goods, services and rights as in Fig. 1(a)). Fig. 2(a) shows that at least one operant resource must act in a service and at least one resource must be acted upon, meaning that service implies the application of competences which must be integrated with other resources to create value. These *acts in* and *is acted upon in* relations replace the stockflow relation of Fig. 1(a).

The system theoretic definition of service system in [8] further specifies that service systems are themselves resources, more particularly operant resources. As service systems are configurations of resources, service systems can be composed of other service systems. A composition of resources needs to include an operant resource, otherwise it cannot be considered a service system [8]. The model in Fig. 2(a) emphasizes the component structure of service systems rather than that of economic resources by replacing the composition aggregation relation and control relation in Fig. 1(a) by a single *controls* aggregation relation.

The service systems involved in a service are explicitly identified via value co-creation roles. A *resource provider* co-creates value with another service system (i.e., a resource integrator) for the benefit of that other system by providing/applying resources. A *resource integrator* co-creates value with another service system (i.e., a resource provider) for its own benefit by integrating the resources provided/applied by the other system. These roles replace the provider and receiver roles in Fig. 1(a).

Finally, the model includes a bidirectional *is reciprocal of* relation between services that replaces the duality relation in Fig. 1(a). Mandatory participation constraints indicate that each service needs a reciprocal service. This means that when a service system provides resources for a service that benefits another service system, then this other service system must provide resources for a requiting service that benefits the first service system. So, in the requiting service the resource provider and integrator roles of the service systems that co-create value are switched.

Applying the RSS model to the example of a car oil change results in the model shown in Fig. 2(b). Car oil change is identified as a service in which a garage and a car owner participate in the respective roles of resource provider and resource integrator. The car mechanic is an operant resource controlled by the garage that acts upon the car which is an operand resource controlled by the car owner. In the service, other operand resources controlled by the garage (e.g., motor oil, a garage pit, and garage tools) are acted upon as they are appliances for the oil change competences embodied in the car mechanic. Payment is the reciprocal service of car oil change. The resources that are acted upon or act in the payment service are also modelled: the car owner's payment competences (i.e., knowledge of how to effectuate payments), his money, and a bank account as an operand resource that the garage brings in. Note the two essential differences with the REA model in Fig 1(b). First, there is no need to model both a service and a service transfer. Second, the resources brought in by the resource integrator (i.e., the car in case of the car owner and the bank account in case of the garage) are explicitly modeled, emphasizing that in each of the reciprocal services value is co-created by both parties rather than created by one party and destroyed by the other party.

2.1 A Service Process Model View

The model in Fig. 2(a) does not elaborate on the process structure of a service exchange, other than recognizing that service is an event, meaning an occurrence in time. The mandatory *is reciprocal of* relation suggests that the pair of services that make up a service exchange concur, as each service needs a reciprocal service. In [13] it is argued that any Service Science model of service systems should capture time. To add a time dimension to the RSS model and to formalize the co-existence of mutually reciprocal services, we extend the model in Fig. 2(a) with a service process model view.

The ‘process’ of service exchange can be seen as a series of interactions (possibly only one) between the involved service systems. In [10] the notion of interaction between service systems was formalized and a normative model (called ISPAR) was proposed that identifies and typifies all possible service system interactions. Service system interactions are described by interaction episodes which are series of activities jointly undertaken by two interacting service systems.[1] The ISPAR model is represented in [10] as a decision tree with ten leaf nodes that represent the different types of outcome for interaction episodes. Six of these outcomes characterize interaction episodes that describe service interactions between service systems, i.e., interactions that aim at mutual value co-creation [8]. A further distinction is made between successful (outcome R), aborted (outcomes –P and –A), and unsuccessful service interactions (outcomes –D, -K, and K) (Table 1).

Table 1. ISPAR outcomes of interaction episodes describing service interactions

Interaction episode outcome	**Interaction type**
(R) mutual value co-creation realized	Successful
(-P) proposal for service interaction(s) not successfully communicated	Aborted
(-A) no agreement reached on proposal for service interaction(s)	
(-D) mutual value co-creation not realized, but not disputed	Unsuccessful
(K) mutual value co-creation not realized, successful dispute resolution	
(-K) mutual value co-creation not realized, unsuccessful dispute resolution	

Fig. 3 shows a model view that can be integrated with Fig. 2(a) to incorporate the concepts and structure of ISPAR in the RSS model. In the service process model view, the *is reciprocal of* relation in Fig. 2(a) is reified such that the process structure of a service exchange can be explicitly represented. As a service exchange object links a pair of objects representing the reciprocal services that constitute a service exchange, and the participation of service objects in these links is mandatory (i.e., each service needs a reciprocal service), the life of a service exchange concurs with the lives of its constituting services. Fig. 3 further shows that each service exchange is composed of one or more service interactions. A constraint not shown is that all service interactions that compose some service exchange are described by the same interaction episode. We consider interaction episodes that describe non-service interactions as outside the scope of RSS as this is a model of service exchange. So, only interactions that aim at mutual value co-creation are considered, even if eventually unsuccessful or aborted.

The ISPAR model can also be used to prescribe a minimal normative lifecycle for the service exchange objects in Fig. 3. Each service exchange, and hence each of the two reciprocal services it relates, starts with an activity that proposes service

[1] Note that ISPAR considers, just as REA and consequently RSS, economic exchange as a bilateral process, so involving exactly two service systems.

interaction(s).[2] The way in which a service exchange (and its constituting services) ends depends on the outcome of the interaction episode. Successful service interactions are described by an interaction episode that is a sequence of three main activities: (1) proposing one or more service interactions; (2) agreeing to this proposal; and (3) realizing the agreed-to service interaction(s). This happy path leads to the result that value co-creation for both service systems is realized, in which case the service exchange and both involved services come to a successful end. For interaction episodes with outcomes –P and –A, the service exchange ends because the service interactions are aborted. In interaction episodes with outcomes –D, K, and –K, the agreed-to service interactions are not (fully) realized and the service exchange might even end with a dispute, which may or may not be successfully resolved.

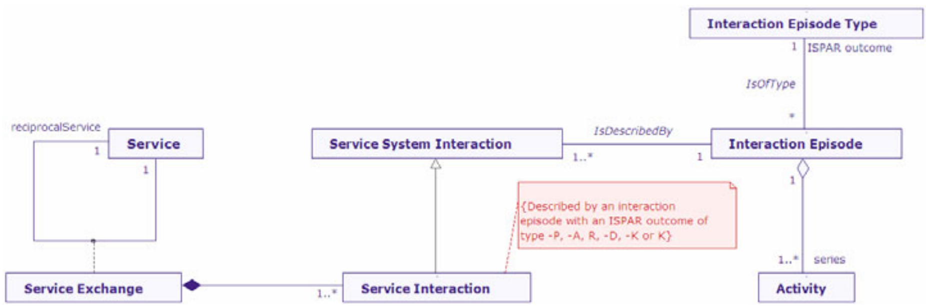

Fig. 3. RSS model: Service process model view

In the car oil change example, an exchange of oil change service for payment requires one or two service interactions: either a single garage visit that is immediately followed by a cash or credit card payment (at the garage's premises); or a single garage visit that is followed by a money transfer from the car owner's bank account to the garage's account, sometime after the oil change took place (e.g., within 30 days). The proposing activity is when the car owner calls the garage to ask for a car oil change and the garage proposes a garage visit. Both parties then need to agree on the conditions/price and on a suitable date/time for the visit. At the scheduled date/time the car owner brings in the car, the oil is changed, and payment is made (immediately or later). Although only one interaction episode really takes place and describes the actual exchange as it happened, many different interaction episodes with different outcomes are possible and can be modeled in a lifecycle model for the service exchange. Examples of unhappy outcomes that may occur include an interrupted or unanswered call (-P), a car owner that refuses the conditions/price offered (-A), and no show-up at the agreed date/time (-D).

[2] This activity can be initiated by one service system (in which case the other service system might not be identified yet or only typified) or jointly by both service systems. A proposal might refer to a single well-defined service interaction or an ongoing series of interactions not completely defined [14].

3 Related Work

A conceptualization of service systems that is often referred to by Service Science researchers (e.g., [1], [13]) is the model defined in [7] (Fig. 4). This model shows that service systems interacting in a service take on provider or client roles, in which the provider takes responsibility for transforming or operating on a service target that is owned by the client. The model is in line with SDL as it emphasizes that the interaction of both systems is required to create value for the client. However, Fig. 4 does not suggest that service systems interact through *service exchange*. In contrast, the RSS model puts strong emphasis on the exchange nature of service. The shift in the logic of economic exchange from resource-for-resource to service-for-service is what SDL is all about [15], so it is hard to imagine how a conceptual model for Service Science can abstract from service exchange. Other differences with RSS are that Fig. 4 does not provide constructs to model the use/consumption of resources in a service and that it does not emphasize the crucial role of operant resources.

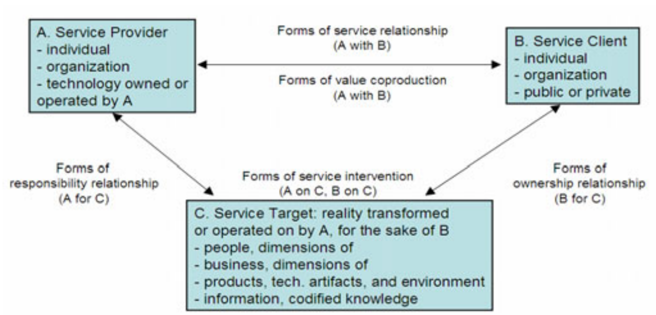

Fig. 4. Conceptual model of service systems interacting in a service [7]

Related to our research, we found two other studies that have applied ideas from value modeling to service modeling in a Service Science context. The REA-based model presented in [16] recognizes services as a special kind of resources that have as goal to modify and add value to other resources. Applying this model to the car oil change example gives Fig. 5.[3] The main difference with the REA model of Fig. 1(b) is that Fig. 5 identifies the service target (i.e., the car) that is owned by the service beneficiary. The oil change service has as goal to transform this service target. Like REA (but unlike RSS), a service is seen as a resource that is consumed in an event (i.e., refill oil), which is not conform to SDL. Furthermore, apart from the service target, the resources brought in by the service systems are not identified, which is different from the RSS model for this example (Fig. 2(b)).

The model presented in [17] can be used to model value encounters, which are interaction spaces between multiple actors in which each actor brings in resources which are then combined to create value for all of them. The model is different from the REA-based model in [16] in that all resources brought in by the service systems

[3] Fig. 5 represents only the car oil change service part of the service exchange, so is an incomplete model used for illustration purposes only. Like the RSS model, the model presented in [16] employs REA's duality relation to model the exchange of service-for-service.

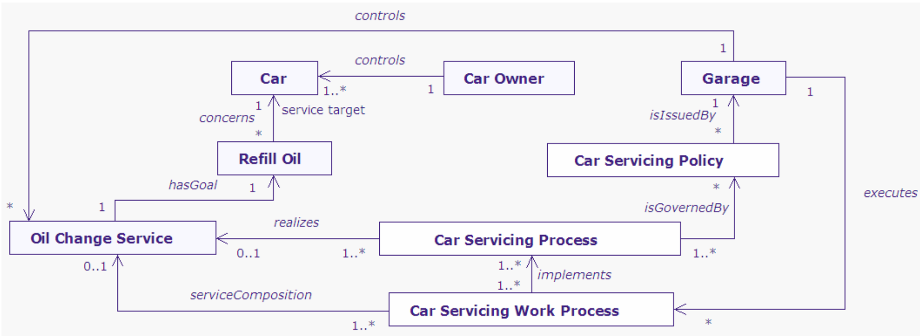

Fig. 5. REA-based model of service [16] as applied to the car oil change example

can be identified. However, the model does not conform to SDL as services "are resources as well" [17, p. 39] and can be "consumed by some other actor" [17, p. 39]. Furthermore, the model does not distinguish operant and operand resources.

In summary, the RSS model is different from these pre-existing models in the sense that it fully conforms to SDL. It (i) considers service as a process (different from [16], [17]); (ii) emphasizes that in an economic context, service is exchanged for service (different from [7]); (iii) can be used to identify all resources that act in or are acted upon in a service (different from [7], [16]); and (iv) distinguishes operant and operand resources (different from [7], [16], [17]).

4 Discussion and Future Research

The RSS model is intended as an instrument to be used in the study of service systems and their interaction in the context of service exchanges. Unlike previous conceptualizations used in Service Science, value models stress that service exchange is the economic motive for service systems to engage in service interactions, which makes RSS potentially useful for Service Science research aimed at service management and service engineering applications. According to [18], such a focus can broaden the perspective of service management and service engineering, which traditionally emphasize the difficulties created by the inherent inefficiencies of producing services instead of goods, to the efficient and effective mutual value co-creation in service ecosystems. The model can, for instance, be used to identify all resources that the resource providing and integrating service systems contribute in an exchange of mutually reciprocal services, which may be useful for service innovation and design (e.g., designing new service offerings), service operations (e.g., resource acquisition, subcontracting and outsourcing decisions), and service management in general (e.g., cost accounting, pricing, profitability analysis). Further, lifecycle models for service exchanges help identifying the different states in which a certain type of service exchange can be, which may be useful for simulating or monitoring service executions. The history of a service system can be expressed as a sequence of interaction episodes with other service systems [14]. The distribution of outcomes over time can be a significant performance measure for service systems with respect to their service offerings [10]. Such measurements may prove useful for optimization and improvement initiatives, and for service engineering in general.

Further research is required to evaluate the external validity of the model by applying it to a wide range of service contexts. We also plan to extend the model with the Service Science notion of value proposition, which is another key concept in the study of service systems. As ultimately the utility of the RSS model as a research instrument for Service Science depends on the SDL mindset that it reflects, future research may be directed towards an evaluation of SDL as a foundation of Service Science.

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