Chapter 4
Four Axiomatic Requirements for Service Systems Research

David Reynolds and Irene CL Ng

Abstract Service science research is a rapidly growing interdisciplinary, cross-functional discipline. As such, it is necessary for formal structures to be created to focus researchers' efforts towards a common end. This chapter starts with an overview of the role of service-dominant logic and systems thinking in service science, lending support to the assertion that service systems should be the 'basic abstraction' of service science research. The chapter then proceeds to argue for four axioms which are necessary to progress knowledge in the domain of service systems.

Keywords Emergence • Holism • Resource integration • Service systems • Service-dominant logic

1 Introduction

We are now over 10 years into the fifth period of service research (2000–present), called the 'Creating Language' period by some researchers (IfM and IBM 2007; Keränen and Ojasalo 2011; Briscoe et al. 2012). In their review of the 2011 Grand Challenge in service conference, held at the University of Cambridge, Briscoe et al. (2012) describe the Creating Language period as the time where new models of service emerge and the concept of service systems develops further, uniting different perspectives within service science. The field is expanding rapidly with increasing numbers of researchers, conferences and networks, while initiatives such as

D. Reynolds (✉)
International Institute for Product and Service Innovation (IIPSI),
The University of Warwick, Coventry CV4 7AL, UK
e-mail: d.j.reynolds@warwick.ac.uk

I. CL Ng
International Institute for Product and Service Innovation (IIPSI),
The University of Warwick, Coventry CV4 7AL, UK

Marketing and Service Systems, Warwick Manufacturing Group (WMG),
The University of Warwick, Coventry CV4 7AL, UK
e-mail: irene.ng@warwick.ac.uk

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service science management and engineering (SSME), introduced by IBM, aim to strengthen interactions between industry, academia and government (Hefley and Murphy 2008).

Building on the work by Agrawal (2001) and Cronin (2003), Moussa and Touzani (2010) call this period the 'airborne' phase (2004–now). They highlighted the following features of this phase:

- In 2004, service science management and engineering (SSME) emerged as a new interdisciplinary field.
- There was a marked increase in the number of service journals being published.
- A significantly larger proportion of articles in leading marketing and management journals are about service.
- New paradigms and concepts have been developed. Some have had greater impact than others (e.g. the service-dominant logic and the rental/access paradigm).
- There has been increased emphasis on the interdisciplinary, cross-functional and international nature of the field. This includes the integration of computer science, operations research, engineering, management, marketing, social and cognitive sciences and legal sciences.

Service science has gained popularity amongst academics and practitioners as it is seen by some as a way to drive innovation, competition and quality of life through the co-creation of value (Moussa and Touzani 2010; Ostrom et al. 2010).

A variety of fields, traditions and methods are being utilised in this space, from natural and ecological sciences to information technology and cybernetics (Mele et al. 2010). Hence we believe that to move this discipline forward, service science research needs to be structured in such a way as to focus researchers' efforts towards a common end. Few service researchers would disagree with this, and as such, the purpose of this chapter is to clarify some of the key concepts and explore some of the insights gained from what is rapidly becoming a well-developed body of literature.

2 Service-Dominant Logic and Service Systems

Vargo and Akaka (2009) argue that the appropriate foundation for service science research is the service-dominant (S-D) logic, and hence the foundational premises of S-D logic (Vargo and Lusch 2004, 2008; Vargo and Akaka 2009) should form the core of the postulate base (Ng et al. 2012), i.e. adherence to S-D logic is a necessary condition for service science research. The four core foundational premises are summarised in Table 4.1.

As set out in FP1 in Table 4.1, service[1] is the basis of all exchange. In other words, service is always exchanged for service.

[1] Singular, indicating a process as opposed to the plural *services*, indicating intangible units of output.

Table 4.1 Core foundational premises of service-dominant logic

Logic premise		Explanation/justification
FP1	Service is the fundamental basis of exchange	The application of operant resources (knowledge and skills), 'service', is the basis for all exchange. Service is exchanged for service
FP6	The customer is always a cocreator of value	Implies value creation is interactional
FP9	All economic and social actors are resource integrators	Implies the context of value creation is networks of networks (resource integrators)
FP10	Value is always uniquely and phenomenologically determined by the beneficiary	Value is idiosyncratic, experiential, contextual and meaning laden

Source: Vargo and Akaka 2009

When service is exchanged, one entity integrates resources, which are 'unique, or otherwise costly-to-copy, inputs' (Conner 1991). A traditional product is therefore a bundle of potential resources proposed to the consumer and service and is defined as the application of the competency afforded by the potential resources that become actual resources to be integrated by the consumer in context.

It can also be argued that it is the integrator that determines whether or not the service was of benefit to them. In other words, *value* can only be created within the mind of the *beneficiary of service* (*consumer*), through the application of their own competencies with those provided by the value proposition in question (Ng 2013). This is known as *value co-creation*.

Value co-creating entities, be they individuals, groups, organisations, firms or governments, are often viewed as interacting with one another within systems, constellations or networks of resources (e.g. (Normann 2001; Normann and Ramírez 1994; Vargo and Lusch 2011; Lyons and Tracy 2013). Each of these systems is an arrangement of resources, connected by a value proposition (Spohrer et al. 2007; Lusch et al. 2008; Maglio et al. 2009; IfM and IBM 2007; Smith and Ng 2012) or more specifically 'service systems'.

Many service researchers therefore turn to systems science for their research, not only because the general systems theory provides the foundation for creating a formal structure of service systems (Maglio et al. 2009; Golinelli et al. 2002)[2] but also because these frameworks exhibit greater robustness arising from their development over some 50 years (Spohrer et al. 2012). Systems science also provides an established lexicon of systems characteristics which can be used to formulate a research agenda for service systems (Ng et al. 2011). These characteristics include: boundaries, interfaces, hierarchy, feedback and adaptation to which most systems writers would add emergence, input, output and transformation (Kast and Rosenzweig 1981; Christopher 2010).

[2] For a detailed review of some of the main systems approaches, such as general systems theory (Bertalanffy 1972) and open systems theory (Boulding 1956; Katz and Kahn 1978).

Table 4.2 Recent service system definitions

Service system definitions	Authors	Year
Service systems represent value co-creation configuration of people, technology, value propositions connecting internal and external service systems and shared information	Spohrer, Maglio, Bailey and Gruhl	2007
Service systems can simply be a software application, or a business unit with an organisation, from a project team, a business department, a global division; it can be a firm, institution, government agency, town, city or nation; it can also be a composition of numerous collaboratively connected service systems within and/or across organisations	Qiu, Fang, Shen and Yu	2007
Service systems act as resource integrators, understandable in terms of elements of a work system, within the organisation and through the network enduring resource specialisation, those operand and operant, such as knowledge, skills, know-how, relationship, competences, people, products, money, etc.	Spohrer, Anderson, Pass and Ager	2008
Every service systems is both a provider and client of service that is connected by value propositions in value chains, value networks or value-creating systems	Vargo, Maglio and Akaka	2008
A service system is any number of elements, interconnections, attributes and stakeholders interacting in a co-productive relationship that create value, in which principal interactions take place at the interface between the provider and the customer	Spohrer, Vargo, Maglio and Caswell	2008
Service systems are a complex interplay between firm and customer that form an open system which needs to be designed using the techniques of viable systems and systems dynamics, in which both parties are focused on achieving outcomes	Ng and Maull	2008
	Ng, Maull and Yip	2009
Service systems can be divided into 'front stage' (about provider/customer interactions) and 'back stage' (about operational efficiency), and service performance relies on both of them, putting people (customers and employees), rather than physical goods, in the centre of its organisational structure and operations. The smallest service system is a single person; the largest one is represented by the global economy	Qiu	2009

Source: Barile et al. 2012

The link between a systems science approach and modelling and understanding service has been emphasised by many authors (Barile and Polese 2010; Golinelli et al. 2002; Ng et al. 2012; Briscoe et al. 2012). As seen in Table 4.2, there have also been many attempts to define service systems. However, it was Maglio et al.'s (2009) seminal work which really brought forward the application of systems science to service research. In it, they proposed the service system as the *basic abstraction* of service science. Their definition of a service system, was

> *"an open system (1) capable of improving the state of another system through sharing or applying its resources* (i.e., *the other system sees the interaction as having value), and (2) capable of improving its own state by acquiring external resources* (i.e., *the system itself sees value in its interaction with other systems). In this context, economic exchange depends on voluntary, reciprocal value creation between service systems (each system must willingly interact, and both systems must be improved)."* (Maglio et al. 2009)

Despite this attempt at formalisation, they had only just begun the process of abstraction for service science (Maglio et al. 2009). As a result, the stage is set for service researchers to identify and develop exactly how a service system might be investigated.

Some other examples of service system definitions can be found in Table 4.2.

As evident from the table above, there are many different systems approaches which could be applied to service systems (Mele et al. 2010). This also means that not all perspectives are applicable to service systems, as some contradict others. Of course, with so many disciplines to choose from, it is no surprise that there are a large number of frameworks currently being applied.[3] The word 'systems' is liberally used, even when the authors do not subscribe to the basic tenets of systems science. Often, the word 'systems' is used merely to describe the existence of multiple entities in the same space, regardless of what the relationship is between them. To that extent, the rest of this chapter proposes a set of *axioms* as a starting point for how a *service system* should be understood and researched into.

3 Holism

A system can be defined as an entity, which is a coherent whole (Ng et al. 2009), meaning it is not simply the sum of its parts (Godsiff 2010; Mele et al. 2010). This is not to say that the parts are unimportant. Systems thinking instead emphasises the importance of the *relationships* between parts (*entities*) and not the individual parts themselves (Forrester 1958; Ng et al. 2009; Godsiff 2010; Mele et al. 2010). This is known as *holism*.

From the service science literature, there is a feeling that holistic and interconnected approaches are an appropriate starting place for describing service (Godsiff 2010). Some authors go even further and suggest that the whole range of complex human social systems are actually instances of nested, networked *holistic* service systems (Spohrer et al. 2012).

For example, the socio-technical school draws the general conclusion that the social and psychological aspects of work need to be understood in the context of the task and the way in which the technological system as a whole behaves (Emery and Trist 1960). The technology system here is taken to include not only the hardware, machines, etc., but the methods and procedures of work and how that work is organised in a process. Similarly, recent research in socio-materiality challenges the assumption that technology, work and organisations should be conceptualised separately and advances the view that the social and technical (material) worlds are inseparable, or constitutively entangled (Orlikowski and Scott 2009). This means all entities in the system must be considered, regardless of whether human, material or technological.

[3] It is not within the scope of this chapter to discuss all the different models of service systems currently being pursued by other service science researchers. It should also be stressed that 'no model of any complex system [like a service system] can be completely right… models are neither right nor wrong. Models are more or less useful…' (Christopher 2010).

Schatzki (2003, 2005) exemplifies this concept of entanglement, proposing that central to all human social interaction are practice-arrangement meshes, where human 'practices' interact with material 'arrangements'. These 'meshes' are similar to service systems in that they 'interlace' in such a way that they build larger and larger 'nets'. Schatzki (2005) uses the example of classrooms linking and overlapping with the department office, college administration offices, dorms, the bookstore and the central administration building at the same 'level' to create the university or a 'practice-arrangement bundle' (Schatzki 2005). This could just as easily be called a service system. The university 'bundle' is tied to other educational institutions, state governments, local city governments, foundations, industries and so on to form the larger 'net' (or service system): American education. As with the socio-technical school, context is key and the emphasis is on the relationship between the human (social) and the material (technical).

It has also been suggested that the strength of largely loosely coupled relationships between entities plays a significant role in both the co-creation of value and formation of service systems (Vargo and Akaka 2012). Hence any model of service systems developed is not purely social, technical or material, but a combination of human, material and technological entities which must be considered according to the connection/distinction and reduction/holistic analysis.

Service systems are therefore *holistic* in nature but could also be *reducible.* The two concepts are not mutually exclusive and ideally, any model of service systems should allow for both the observation of a single entity (reductionism) and a system view of the whole (holism) (Mele et al. 2010; Ng et al. 2011, 2012; Barile et al. 2012). The synthesis of these two approaches is crucial towards understanding both the single element and its relationships with other elements without missing the whole picture and its systemic interpretations. This implies that entities within a system have both a distinctive and a connective role. Hence we argue that a fundamental axiom of a service system is that we cannot choose to consider one role without the other:

First axiom of a service system: Systemic entities must be discussed based on both connective and distinctive roles within the system and how tightly coupled its entities are. Reducibility analysis must therefore report on the implications to the system's holistic nature.

This is consistent with many of the current models being proposed within service systems research. For example, Knowledge Based Service Systems (De Santo et al. 2011)[4] are the convergence of advances in IT tools with the evolution in thinking about system dynamic interactions, adaptive skills, sustainable development, enhanced learning, reconfiguration capacities and service innovation (IfM and IBM 2007) in complex environments (Basole and Rouse 2008).

[4] An extension of *smart service systems (SSS)* (Barile and Polese 2010). SSS are greatly concerned with the interconnected nature of the actors in the system. In particular, the relationships between actors may not, at first, be obviously of interest. Proponents of SSS argue that this focus really contributes to the competitiveness of the whole system.

Similarly a work system (Alter 2008, 2012) is defined as a system in which human participants and/or machines perform processes and activities using information, technology and other resources to produce products/services for internal or external customers (Alter 2012).

Despite being clearly based on the 'traditional' goods-dominant logic, even a product-service systems approach (Baines et al. 2007) leads to conceptualising the firms' offering as an integrated view of material (tangibles) and nonmaterial (intangibles) components with the collective aim of fulfilling customer needs (Smith et al. 2012).

4 Emergence

It has already been suggested that service systems can be used to represent a range of complex human systems, including firms, individuals, nations, markets, communities and so on. These are referred to as 'open systems' because they interact with many other systems and exchange resources (e.g. energy, matter and information) (Barile and Polese 2010). An open system suggests a complex and dynamic interaction of the organisation and its environment with undeterminable results (Mills and Moberg 1982), as opposed to a system where no material enters or leaves it (closed). A system is therefore 'open' if it is able to exchange energy, matter and information with its environment (Mele et al. 2010). Hence it can be argued that service systems are often open.

The interactions of the relationships between entities within a service system form a higher-order construct that becomes the driver of value (Lusch et al. 2010), i.e. it is the interaction between entities within the system that drives value and not the entities themselves. Interactions create emergence. An emergent quality is related to the inputs and processes of the system, yet it is unpredictable in the sense that knowing what the individual parts of the system are and how they relate to each other does not necessarily mean one can predict the properties of the whole system (Gummesson 2008; Godsiff 2010). Often, emergence arises from the degree of openness within the system (Bertalanffy 1972).

Ng et al. (2011) provide three insights into this:

a. Organisational life does not often behave in one-way causality, i.e. the elements of the system acting on each other are both changed in some way through their interaction with each other.
b. Emergence is very hard to predict because of the number of elements that interact to produce the property.
c. Not only does the interaction between two elements change them, but often something is produced in the interaction which is 'greater than the sum of its parts' (Ng et al. 2011).

Hence while some service systems that are loosely coupled may not exhibit a high level of emergence, e.g. a bank loan application and approval system, the emergent property must still be reported nonetheless to be consistent with systemic approaches.

Second axiom of a service system: Even while much of the outcome of a service system could be predictable, a service system must exhibit some emergent property.

An example of emergence as applied to value co-creation (and by extension service systems) is how an appreciative system[5] develops a series of 'norms' over time which are responsible for its regulation and are not predictable/programmable (Regev et al. 2011).

5 Perspective and Boundaries

One of the challenges with open systems (and by extension, open service systems) is that due to the easy exchange of resources, it can be difficult to identify what is actually part of the service system and what is just part of the wider environment. In order to deal with this issue, the boundary of the system in focus must be defined.

The boundary is a subjective concept, sometimes called the 'interface' or 'membrane' (Godsiff 2010), which differentiates one service system from another. As service systems are often 'open', the boundary will have points at which two (or more) open systems interact. The definition and interpretation of a given boundary varies according to circumstances. However the definition of a system boundary depends on the 'view point' of the system in focus. This can vary depending on the 'actor in focus' and even applies to entities which are not living, such as firms.

It is often implicitly assumed, when viewing and discussing a service system, that the perspective is that of an outsider looking in, i.e. a positivistic and objective view of the system. However, the same system could be understood and described very differently from every entity within the system (Checkland and Poulter 2006; Alter 2008, 2012). Similarly Regev et al. (2011) note that 'the very "function" of a service is likely to be a subject to debate amongst its stakeholders'.

Each entity's decision process at different points of the service system is different, and every system could have a separate set of boundaries depending on the perspective taken. That said, each entity still invokes abductive, inductive and deductive forms of the entity's descriptive model of the world and the formulation of decision rules (optimal, heuristic, intuitive, irrational) that can be used for determining a decision (Ng et al. 2012).

Hence a service system may exhibit outputs that could be both deterministic (predictable) and emergent due to the nature of the interactions between decisions made and the level of autonomy between the entities. The more autonomous the entity, the less likely the outputs will be predictable. So, for there to be a consistent analysis of a service system, the perspective and boundaries of the system must be made clear from the outset.

[5] A specialisation of general systems thinking proposed by Vickers (1968) as a way to model how humans and organisations understand and act on their environment.

Third axiom of a service system: The boundaries and perspective of a service system must be specified and held consistent across all discussions.

As a case in point, the definition of the system boundaries is essential when adopting the viable systems approach (VSA) (Golinelli et al. 2002), due to the recursive nature of the model.[6] By introducing the need to report on perspective and boundaries, the third axiom would naturally lead to the role and function of the system, the scope of what it is for and whom it serves from whichever perspective. This echoes Schatzki's (2005) 'site ontology' in that an entity (or event) is tied to context and equally context is tied to the entity (or event). Neither one can exist without the other.

6 Resource Integration and Competencies

All social and economic actors are resource integrators, which are capable of contributing to value co-creation (Barile et al. 2010; Barile and Polese 2010; Vargo and Akaka 2012). Similarly, it has been argued that entities involved in service provision act as integrators of various resources (such as knowledge, skills, know-how, competencies, material resources, money and so on) (Maglio et al. 2009).

Chandler and Vargo (2011) emphasise how social contexts influence, and are influenced by, value co-creation processes within and amongst systems of service exchange. Models of resource integration must define the dynamic and context-specific configurations of form, time, place and possession of resources that achieve the 'density' that is necessary for optimal value creation (Lusch et al. 2010). Density, as defined by Normann (2001), is a measure of the amount of information, knowledge and other resources (e.g. institutions) that an actor has at any given time and/or place to solve problems. Therefore a service system co-creates value for a specific actor through the integration of resources and the availability of potential resources specifies the density of the context.

Since service is an application of competency through which an entity integrates resources to co-create value, competencies of entities within the system could be described through their agencies (capacity of an individual to act independently and to make their own free choices), if human, or their affordances (the quality of something that allows an actor to perform an action upon it), if material (Ng 2013). The decision to act requires judgement, which is based on the context of the system (Ng 2013). In other words, resource integration and competencies arise (and value is created) when agencies take effect in practices and affordances are enacted upon to achieve the systemic outcome, within a specific context.

[6] This is an extension of the viable systems model (VSM) (Beer 1984) which has been applied to political systems of nations, pharmaceutical companies, electricity companies and SMEs (Vidgen 1998; Achterbergh and Vriens 2002; Hoverstadt and Bowling 2002; Schwaninger et al. 2004; Haslett and Sarah 2006).

Fourth axiom of a service system: A service system must report the competency (i.e. ability to render the service) of entities within the system.

For example, Alter (2008, 2012) emphasises the need for service to benefit someone (or something), not just the provider of the service. This includes the provision of resources that others will use. Smart service systems (SSS) (Barile and Polese 2010) are 'smart' because they change the way resources are utilised to reflect a change in their environment (Barile and Polese 2010).[7] Similarly, Knowledge Based Service Systems do not only describe the relationships between entities in a system but also identify and classify the resources employed in the process of services exchange between entities (De Santo et al. 2011).

7 Conclusion

We argue that these four axioms, grounded in systems science and S-D logic, are necessary to progress knowledge in the domain of service systems. They will serve to ensure consistency in elucidating implicit assumptions of service systems research and development. Further research is needed to develop models of service systems based on these axioms. We anticipate that the development of predictive models will be particularly challenging. Identifying all of the potential outcomes where there are many interacting elements (all the potential states of the system), and taking into consideration the non-linear relationships and multiple potential feedback loops, means that the results may well be impossible to predict. Hence any model of service systems which claims to be predictive is likely to be very complex (Ng et al. 2011).

Just as the 'winners' of the industrial revolution were the firms who were able to make 'things' for their customers faster and, more efficiently, the 'winners' of the digital revolution will be the firms who are able to serve their customer needs better, we believe, as do many others, that the Art and Science of Service Systems will provide the necessary tools to do this.

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[7] This is made possible through the application of information and communications technology (ICT) with significant emphasis on automation, or minimal human involvement. Ideally, SSS are capable of self-reconfiguration in order to deliver the best possible performance to satisfy all actors in the system (Barile and Polese 2010).

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