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ORIGINAL ARTICLE

Technology as an operant resource in service (eco)systems

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Abstract In this paper, we explore the role and scope of technology in value co-creation, service innovation and service systems—value co-creation configurations of people technology and value propositions (Maglio and Spohrer in J Acad Mark Sci 36:18–20, 2008). We draw on a structurational model of technology (Orlikowsky in Organ Sci 3(3):398–427, 1992) to provide a framework for considering the role of technology in service systems and how it influences and is influenced by human actions (i.e., practices) and institutions. We broaden the scope of technology in this model, beyond a material artifact, or outcome of human actions, by applying an S-D logic, service ecosystems (Vargo and Lusch in J Market 68(1):1–17, 2004, Ind Mark Manag 40(2):181–187, 2011a) approach, which focuses on the processes by which value is co-created and new ways of creating value (i.e., innovation) emerge. In this view, technology can be conceptualized as an operant resource—one that is capable of acting on other resources to create value—and, thus, becomes a critical resource for value co-creation, service innovation and systems (re)formation. We argue that the consideration of technology as an operant resource in service (eco)systems provides a more encompassing view for systematically studying the way in which technologies are integrated as resources, value is collaboratively created, and service is innovated.

Keywords Service ecosystems · Service-dominant logic · Operant resources · Value co-creation · Service innovation

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1 Introduction

Technology is one of the central constructs in the study of service, service science and value co-creation. According to Maglio and Spohrer (2008, p. 18), service science is the study of service systems, and "service systems are value-co-creation configurations of people, technology, and value propositions connecting internal and external service systems and shared information (e.g., language, laws, measures and methods)." In this view, technology contributes to the co-creation of value by enabling the sharing of information within and across service systems. Importantly, Bitner et al. (2010, p. 197) argue that recent advances in technology have profoundly changed the nature of service provision and influenced how service is delivered, innovated and managed. Similarly, Rust (2004, p. 24) suggests that "the service revolution and the information revolution are two sides of the same coin," which are both driven by technological change. Although technology has been recognized as an important factor in value co-creation and service systems (Maglio and Spohrer 2008), traditional views of the role and scope of technology.

This paper contributes to developing a deeper understanding of the nature of technology and its role in value co-creation and service innovation. We apply a service ecosystems approach (Vargo and Lusch 2011a), which is based on service-dominant (S-D) logic, and emphasizes the dynamic qualities of technology and how it can contribute to value co-creation at multiple levels—micro, meso and macro—of interaction (Chandler and Vargo 2011). Service ecosystems are defined as "relatively self-contained self-adjusting systems of resource integrating actors connected by shared institutional logics and mutual value creation through service exchange" (Vargo and Lusch 2011b). This view underscores the importance of institutions in value co-creation and draws attention toward technology as an operant resource—one that is capable of acting on other resources in value creation.

To better understand the relationship between technology, interaction and institutions, we draw on a structurational model of technology (Orlikowsky 1992), which suggests that, technology influences and is influenced by institutions—social norms or "rules of the game" (Williamson 2000)—as well as the actions, or practices, of social and economic actors (Giddens 1984). Although this structurational model provides insight to the role of technology in value co-creation and service innovation, the scope of technology in this model is focused on "material artifacts," or "outcome or human actions," and limits the understanding of processes by which value is co-created and innovation occurs (Arthur 2009). Thus, we rely on S-D logic's emphasis on operant resources to extend the scope of technology beyond the *output* of human action (Orlikowsky 1992), and define technology as a collection of *practices and processes*, as well as symbols (Spohrer and Maglio 2010), that are drawn upon to serve a human purpose (Arthur 2009). Ultimately, we argue that a service ecosystems approach for conceptualizing technology as an operant resource provides a more encompassing view of the way in which technologies are integrated as resources, value is co-created, and service is innovated.

2 The scope and role of technology in service innovation

Technology is a critical component in service provision (Bitner et al. 2010) and value creation (Maglio and Spohrer 2008). Traditional views of technology separate the development of technology from its use, and suggest that value is created through the development phase and subsequently destroyed through the use phase (Normann 2001; Orlikowsky 1992). This conceptualization of technology in service innovation was developed from manufacturing models centered on "product" development. The focus on technological advancements of goods and firm operations in innovation has been a topic of debate and deliberation since the end of the twentieth century (Drucker 1985). Recent research (e.g., Coombs and Miles 2000; Drejer 2004) points toward an evolution in service innovation, which has transitioned from assimilation and demarcation approaches toward a "synthesis" approach. Ultimately, this evolution increasingly emphasizes the importance of service-oriented innovation and points toward a "prospect of opening up a new world of innovation concepts and indicators that effectively transcend the distinction between 'manufacturing' and 'services' sectors (Coombs and Miles 2000, p. 86)."

This unified approach to innovation is based on the idea that the overarching qualities of service can contribute to developing a better understanding of innovation in general (Gallouj and Savona 2009). "In other words, the focus on service sectors has served to throw light on neglected elements of the whole economy" (Coombs and Miles 2000, p. 96). Importantly, the synthesis approach to service innovation establishes industry boundaries based on innovation dynamics rather than characteristics of output (e.g., tangible goods and intangible services) (Preissl 2000). Coombs and Miles (2000, p. 100) argue, "we are moving away from a model of innovation that puts all the emphasis on artifacts and technological innovation; and towards a model which sees innovation in terms of changes in market relationships but with major artifact and technological dimensions." In other words, whereas traditional views of innovation emphasize technology as material artifacts, which are embedded within networks of market relationships, recent research suggests that a deeper understanding of market relationships is needed in order to better understand how to systematically innovate service.

The synthesis or integration (Gallouj and Savona 2009) of traditional approaches to service innovation—assimilation and demarcation—requires an approach that considers the development of new resources as well as relationships. The literature on *innovation systems* provides insight to the relationship between resources and relationships in innovation. According to Andersen et al. (2000) innovation systems are dynamic bundles of resources that create and disperse new knowledge as a consequence of the division of labor and the exchange and application of useful and practical knowledge. These systems can be focused on scientific and technological or managerial and operational innovations, and continuously aim to keep the market system far from equilibrium status.

Sunbo and Gallouj (2000, p. 61) present two types of innovation systems (p. 71): (1) *institutional*—a coherent system with fixed relationships among actors through which knowledge and ideas transfer and innovations are diffused in a linear manner, and (2) *loosely coupled*—a dynamic constellation between actors and environmental trajectories, "ideas and logics diffused through the social system," without fixed behavioral patterns or processes. Whereas institutionalized innovation resides in coherent systems, made up of a series of fixed relationships and certain patterns of diffusion of ideas, loosely coupled innovations characterize dynamic and changing industries where behavior patterns adapt and evolve just as rapidly as, or even faster than, the technological advancements are made. According to Sunbo and Gallouj (2000), loosely coupled systems differ from institutionalized innovation systems in that there are no fixed norms and behavior and relationships are dynamic and changing.

The apparent bifurcation of innovation systems as "institutional" or "loosely coupled" seems to suggest that traditional "manufacturing" innovations are more easily associated with institutional innovation and "services" innovations—with "lack of coherence" and "few patterns of repetition"—are considered loosely coupled (Sunbo and Gallouj 2000). It may also seem that innovation systems surrounding a firm or industry would have to be classified as one or the other. Furthermore, in this view, technology maintains its distinction as an output of human action, which may or may not keep up with human adaptation, depending on the system within which it is embedded. This characterization of different types of products or services, or even service systems, directs attention away from fundamental aspects value creation, and continues to limit the view of the scope and role of technology in innovation. In the following section we discuss an alternative framework and argue that viewing technology and innovation through an S-D logic, service ecosystems (Vargo and Lusch 2011a) perspective can help to address the need for synthesizing various viewpoints by providing a transcending logic that focuses on the integration and application of resources as the basis of value creation and driver of interaction and exchange.

3 A service ecosystems view

In general, S-D logic is a lens or perspective that recognized emerging trends in marketing (e.g., Gummesson and Gronroos 2012; Hunt 2002; Prahalad and Ramaswamy 2004) and was introduced as a way for synthesizing and articulating an alternative view of exchange and value creation in markets (Vargo and Lusch 2004). It provides an alternative approach to traditional economic views or a "goods-dominant" (G-D) logic (Vargo and Lusch 2004), which focus on the production and consumption of goods, as it is centered on the idea that service—the application of competences for the benefit of another—is the basis of all social and economic exchange (Vargo and Lusch 2004, 2008). In this view, service-for-service exchange is driven by the integration of resources and the collaborative creation, or co-creation, of value. The main tenets of S-D logic are (1) service is the basis of exchange, (2) value is always co-created among multiple stakeholders, (3) all social and economic actors are resource integrators, and (4) value is always contextually and phenomenologically derived (see Vargo and Lusch 2008 for details). Importantly, this service-centered view provides a broader and more encompassing view for studying value creation, and, thus, innovation.

Most recently, Vargo and Lusch (2011a), discuss a service ecosystems view, which is based on S-D logic and emphasizes the dynamic and evolutionary nature of systems of service-for-service exchange. Importantly, a service ecosystems approach emphasizes the role of institutions—shared norms or "rules of the game" (Williamson 2000) in value co-creation and service exchange (Vargo and Lusch 2011a). In this ecosystems view, institutions influence the co-creation of value in different ways, especially by providing guidelines as to what is considered to be a valuable resource in a particular place and time, and how such resources can be accessed, adapted and integrated in a specific context (Akaka et al. 2012). This ecosystems view draws attention toward the importance of (1) the interaction within and among service systems, (2) the social context that frames value co-creation, and (3) the recombination of resources in innovation. Table 1 outlines the differences between S-D logic and more traditional, G-D logic views of value creation. S-D logic concepts are elaborated below.

3.1 Value co-creation

One of the central premises of S-D logic is that value is always *co-created* among multiple stakeholders and derived by customers, because value is contextually and phenomenologically determined (Vargo and Lusch 2008, 2011a; Vargo et al. 2008). This view on contextual value, or "value-in-context," is based on the idea that value is always determined by a service beneficiary, through the use of particular resources, in a specific context. In this perspective, the value of any given resource may be evaluated differently by different actors, or by the same actors in different contexts (e.g., time, place, social surroundings) (Akaka and Chandler 2010). This is an important consideration for conceptualizing value creation because it emphasizes multiple viewpoints, and the importance of social relations as well as collective norms and meanings in value creation (Chandler and Vargo 2011; Edvardsson et al. 2011). In addition, the consideration of value co-creation removes the roles of firms as "producers" and customers as "consumers" of value. The consideration of all economic and social actors as resource integrators, service providers and recipients, and contributors to value creation emphasizes the roles and responsibility, as well as the competences, of customers especially with regard to issues such as service quality (Berry et al. 1994) and fulfilling service guarantees (Hart 1988).

Table 1 G-D logic versus S-D logic on value creation

	G-D logic	S-D logic
Process of value creation	Value-added activities	Value co-creation
Central view of value	Value-in-exchange	Value-in-context
Participants in value creation	Firm	Multiple stakeholders
Central resources	Operand resources	Operant resources
Driver of value creation	Production	Resource integration
Context of value creation	Firms	Service ecosystems

Recent research on the concept of "value-in-context" sheds light on how customer networks and configurations of various stakeholders (Akaka et al. 2012; Chandler and Vargo 2011) influence the value created through service-for-service exchange. In particular, Edvardsson et al. (2011) point toward the way in which social contexts influence and are influenced by interaction in markets. With regard to technology, the concept of value-in-context suggests that the value of a particular technology (e.g., problem-solving process) is dependent on the context within which it is applied. In this way, a particular technology can emerge as a resource or a resistance (Zimmerman 1951) depending on the competence of the service beneficiary (e.g., customer) and a variety of contextual factors, such as time and place as well as social and cultural influences.

Edvardsson et al. (2011) argue for a model of "value-in-social-context," which elaborates the nature of the social systems within which resources are integrated and value is co-created. Importantly, the authors note that "individuals cannot create social systems; rather, they can only re-create or transform systems" (p. 331). In other words, as actors interact and form new ways of creating value—i.e., new technology—they can potentially re-create and transform existing systems of relationships and resources (Akaka et al. 2012) into new systems (e.g., service systems). In this way, innovation is driven, not by the discovery or creation of new resources or systems, but by the recombination of existing resources and ongoing efforts to maintain and develop new relationships, as well as new ways of creating value (Arthur 2009).

3.2 Integration of operant (and operand) resources

The literature regarding S-D logic recognizes two broad classification of resources that are integrated to create value: (1) operand resources—those that require action taken upon them to be valuable and (2) operant resources—those that are capable of acting on other resources to contribute to value creation (Constantin and Lusch 1994; Vargo and Lusch 2004). Importantly, S-D logic emphasizes the primacy of operant resources over operand resources in value co-creation. In other words, although operand resources often contribute to the co-creation of value, without the application of operant resources, such as knowledge, skills and competences, value co-creation cannot occur (Vargo and Lusch 2004).

In line with this distinction between operant and operand resources, Maglio and Spohrer (2008), recognize four categories of resources in service systems: (1) resources with rights, (2) resources as property, (3) physical entities, and (4) socially constructed resources. Just as S-D logic focuses on the primacy of operant (dynamic and intangible) resources in value co-creation and the influence of institutions in service ecosystems, Spohrer and Maglio (2010, p. 159) also suggest that socially constructed resources are "increasingly important as a mechanism for value co-creation." In particular, the authors argue that symbols are a central feature of service systems, and processes of value co-creation often require the abilities of individual actors to "manipulate" or re-interpret symbols in service systems to develop new meanings, and ultimately new ways of creating value. This suggests that operant resources are not only important for co-creating value on an ongoing basis, but they are also the central resources in developing new ways for creating value (i.e., new technologies).

Within an S-D logic, ecosystems view, the integration of operant (as well as operand) resources is central to the co-creation of value as well as service innovation (Vargo and Akaka 2012). However, Vargo and Lusch (2004, p. 2) argue that "resources are not, they become." This is because all potential resources can also be considered as potential resistances as well (Zimmerman 1951). With regard to technology, this view suggests that a particular technology may or may not be considered a resource. The determination of a technology as a resource stems from the unique and phenomenological viewpoint of a particular actor, as well as the context through which the application of a technology and the evaluation of its value occurs (see value-in-context section above). Based on this, Akaka et al. (2012, p. 21) argue, "value is influenced by a variety of internal and external factors, including, but not limited to, the ability to access other operant and operand resources."

3.3 Service ecosystems: systems of service systems

S-D logic's ecosystems approach provides a view of value co-creation and innovation that enables the oscillation among micro-, meso- and macro-level perspectives (Chandler and Vargo 2011). This is important for studying innovation in systems of service-for-service exchange because, according to Vargo et al. (2008, p. 149), "We can consider individuals, groups, organizations, firms, and governments to be service systems if they can take action, apply resources, and work with others in mutually beneficial ways." Thus, interactions, including the exchange of resources, in ecosystems can occur at micro levels (e.g., dyadic exchange encounter), meso levels (e.g., organizations), and macro levels (e.g., countries) (Vargo et al. 2008). According to Akaka et al. (2012, p. 19),

> The process of exchange appears increasingly complex as it is more closely examined through an S-D logic ecosystems lens. S-D logic proposes that the fundamental driver of exchange, service, is masked by indirect exchange. Within a service-ecosystems view, what is fundamentally an exchange of service-for-service, becomes a complicated web when organizations, monetized exchange and multidimensional interactions are included.

Furthermore, Lusch and Vargo (2006) argue, "macro systems, which undoubtedly should be studied in their own right come about or emerge from micro phenomena" (p. 410). This ecosystems view suggests that direct service-for-service exchange is masked by indirect interactions, at multiple levels. It is important to note, however, that the consideration of multiple levels of interaction and value creation not only refers to networks of relationships, but also to the institutions that guide the actions and interactions of micro, meso and macro-level relationships as well (Vargo and Lusch 2011a). In this way, a service-ecosystems view provides a "meta layer" (Chandler and Vargo 2011), which brings in a dynamic systems view. This perspective makes salient the way in which micro-level actions and structures compose meso- and macro- level interactions, as well as structures, and meso- and macro- level structures guide the actions and interactions at the micro-level as well.

With regard to technology, this oscillating view enables the consideration of multiple structures, or institutions, that guide the development, as well as use, of technology as resources (Vargo and Lusch 2011a). This is important because the application of a particular technology—idea, process or product (Arthur 2009)—may vary depending on the level of analysis (e.g., a technology may be used differently by an individual and an organization) and the determination of value for a particular resource is contextual (Akaka and Chandler 2010). In other words, although something might be considered as a resource at one level, the same technology could be considered as a resistance at a different level, or different context. Furthermore, because micro, meso and macro levels are interconnected, changes in a particular technology at one level (e.g., differences in the application of a particular technology at a micro level) will likely, if not inevitably, influence the application of that technology at a different level (e.g., establish new norms and meanings at meso and macro levels). Because of this, as actors interact to integrate resources and co-create value, they simultaneously draw on *and* contribute to the context through which value is derived.

4 Rethinking the nature of technology

S-D logic's alternative view on value creation has important implications for innovation in systems of service-for-service exchange. This view suggests that, just as value is created through interaction among multiple stakeholders, innovation is dependent upon multiple parties and perspectives. Because of its transcending view, S-D logic has been recognized as a theoretical foundation for the study of value co-creation in service systems (Maglio and Spohrer 2008; Vargo and Akaka 2009). It has also been discussed as a "synthesis" approach to innovation (Ordanini and Parasuraman 2011), which emphasizes the (1) the limitations of "assimilation" and "demarcation" approaches to service innovation and (2) the importance of collaboration and competences (i.e., operant resources) in innovation. Furthermore, Michel et al. (2008, p. 54) argue that S-D logic "provides a novel and valuable theoretical perspective that necessitates a rethinking and reevaluation of the conventional literature on innovation."

Although S-D logic provides a framework for reconsidering value creation and service innovation, the nature and role of technology in service innovation has not been fully explored. Understanding the role of technology is important for understanding value co-creation and service innovation because it is one of the central components of service systems and a key driver of value co-creation and innovation. Thus, to further investigate the *role* and *scope* of technology in dynamic social systems, we draw on Orlikowsky's (1992) structurational model of technology. This model is rooted in a practice perspective called structuration theory (Giddens 1984), which suggests that, as actors enact practices—routine activities—they continually reproduce social structures (rules and resources) as well as systems (reproduced relationships). In other words, as actors interact, they draw on and contribute to the social systems within which they are embedded.

At the heart of structuration theory is the duality of structure, and the idea that social structures are composed of two interrelated layers—structures and systems. Giddens (1984) defines *structure* as "recursively organized sets of rules and resources" that exist out of time and space. He defines *system* as the "reproduced relations" among actors that are connected through organized practices, or "situated activities of human agents reproduced across time and space." Importantly, Giddens identifies *structuration* as the conditions that connect structures and systems and enable the reproduction of both. In this view, it is the enactment of organized routine practices and interaction among actors that drive the simultaneous reproduction of both structures and systems (e.g., service systems).

Drawing on Giddens' (1984) duality of structure, Orlikowsky (1992) argues for a duality of technology. In this view, technology is both an outcome of and input for human action. It is both physically and socially constructed by human action and interaction, and because of this, agency and structure are not independent. In other words, "it is the ongoing action of human agents in habitually drawing on technology that objectifies and institutionalizes it" (Orlikowsky 1992, p. 406). Focusing on the role of technology in organizations, Orlikowsky (1992) argues,

> Technology is a product of human action, while it also assumes structural properties. That is, technology is physically constructed by actors working in a given social context, and technology is socially constructed by actors through the different meanings they attach to it and the various features they emphasize and use.

Rather than separating the development phase from the use phase, as is done with traditional models of technology, Orlikowsky (1992) includes both the development and the use of technology into one model—the structurational model of technology. She argues "that we recognize human interaction with technology as having two iterative modes: the *design* mode and the *use* mode" (p. 408, emphasis in original). In her model, these two modes of interaction are "tightly coupled" and technology is both a product and an enabler of human action. Moreover, institutions play an important role in guiding both the development and use of technology. However, because the model is recursive, human actions both influence and are influenced by institutions, and the model depicts "institutional conditions" that guide human interaction with technology, as well as "institutional consequences," or the reproduction—including maintenance and change—of institutions, which is driven by human interactions with technology. In her view, as a particular technology moves from design mode to use mode, it will often take on new norms and meanings and can become disconnected from its original structures and systems.

Orlikowsky's (1992) structurational model of technology explicates the *role* of technology as both a medium and an outcome of human action. However, it is important to note that the *scope* of technology in this model is restricted to the consideration of "material artifacts" or "various configurations of hardware and software" that emerge as *outputs* of human action. Thus, although this model considers the social practices and processes that influence the design and use of technology, the conceptualization of technology itself is largely "goods-dominant" (Vargo and Lusch 2004, 2008). Orlikowsky (1992) argues that conceptually decoupling artifacts from human action enables the conceptualization of material artifacts as the "*outcome* of coordinated human action and hence is inherently social" (p. 403, emphasis added). However, this emphasis on technology as a product or outcome, rather than a process (Arthur 2009), of human action provides a limited view of technology and its ability to influence or contribute to the co-creation of value, and service systems.

Offering a broader view of technology, Arthur (2009) suggests that technology can be considered as a process as well as a product. He argues for a three-part conceptualization of technology, in which technology is considered as (1) a means (e.g., process) to fulfill a human purpose, (2) an assemblage of practices and components, and (3) the entire collection of devices and engineering practices available to a culture (Arthur 2009, p. 28). Arthur explains his distinction between the three meanings of technology:

> A technology-singular – the steam engine – originates as a new concept and develops by modifying its internal parts. A technology-plural – electronics – comes into being by building around certain phenomena and components and develops by changing its parts and practices. And technology-general, the whole collection of all technologies that ever existed past and present, originates from the use of natural phenomena and builds up organically with new elements forming by combination from old ones. (Arthur 2009, p. 29)

In this view, technology is not merely an outcome of human action, but also the practices and processes by which new forms of value or solutions (i.e., new technologies) are created. Based on this, Arthur (2009) posits that innovation occurs through a process of "combinatorial evolution" or the recombining of existing resources to develop what appear to be "new" resources or novel ways of creating value.

Arthur's (2009) view of technology suggests that innovation occurs through the integration of various resources, including the material artifacts discussed by Orlikowsky (1992), but is driven by the application of knowledge and skills, as well as institutions (social norms), and the ability to integrate and apply existing resources in new and innovative ways. This broader view of technology aligns with the S-D logic, service ecosystems (Vargo and Lusch 2004, 2008) approach discussed above. In the sections below, we integrate S-D logic with a dynamic view of technology (Orlikowsky 1992; Arthur 2009) to broaden the scope of technology. This broader, more dynamic view on technology is then elaborated with the conceptualization of technology as an operant resource to provide a framework for considering how technology is integrated as a resource to co-create value and, ultimately, innovate service.

5 Technology as an operant resource

In Orlikowsky's (1992) structurational model of technology, technology can be considered as either an operand or an operant resource because it can be both a medium (operant resources) and an outcome (operand resource) of human action.

Specifically, Orlikowski's model suggests that technology can be considered as an operant resource in service systems because it "facilitates and constrains human action through the provision of interpretive schemes, facilities and norms" (p. 410). Orlikowsky (1992) framework emphasizes the social construction of technology and reinforces the idea that institutions are a critical resource for value co-creation because they guide actions and interactions in service systems. However, "in defining [her] concept of technology, [she] restricts its *scope* to material artifacts (various configurations of hardware and software)" (Orlikowsky 1992, p. 403, emphasis in original).

Orlikowski argues that this limited scope helps to conceptually separate human actions from their outcomes. Although she focuses on how technology is socially constructed, the view of technology as an outcome of human actions, such as design, development, appropriation and modification, neglects to fully consider how new ideas or changes in practices and processes can also establish new solutions or new ways of creating value (i.e., innovation). Furthermore, Orlikowski's structurational model of technology focuses on human actions and institutions associated with a particular material object and removes technology from the wider social context within which it is embedded. The consideration of technology as a collection of practices and processes (Arthur 2009), as well as an outcome of human action, is important for gaining a deeper and broader understanding of value co-creation and service innovation within complex and dynamic systems, composed of multiple practices and overlapping institutions.

S-D logic's emphasis on operant resources and systems of service exchange, points toward a view of technology as a process for doing something, as well as an outcome of human action and *interaction* (Arthur 2009). In this view, innovation occurs, not only through the individual actions of humans (e.g., design), but also through the interaction among multiple actors and the recombination of practices and resources. This view of technological advancement falls in line with Arthur's (2009) notion of technology as an assemblage of practices and components as well as a means to fulfill a human purpose. It is important to note, however, that material artifacts remain an important component in many, if not all, technologies. When an artifact is institutionalized within a service system, it becomes a symbol (Spohrer and Maglio 2010), which represents particular practices and is associated with particular meanings.

The proposed framework draws on Orlikowsky's (1992) structurational model of technology, but broadens the perspective to consider role and scope of technology embedded within service ecosystems, which are composed of a multitude of practices and overlapping institutions. Integrating Arthur's (2009) view of technology, we define technology as *a combination of practices, processes and symbols that fulfill a human purpose.* With this broader, service ecosystems view of technology, the practices enacted to integrate resources and the institutions that influence and are influenced by those practices become important components in innovation. Figure 1 identifies the central components of innovation—technology, practices and institutions—and depicts the processes of innovation within service ecosystems. The three components and the relationship among them are discussed below.

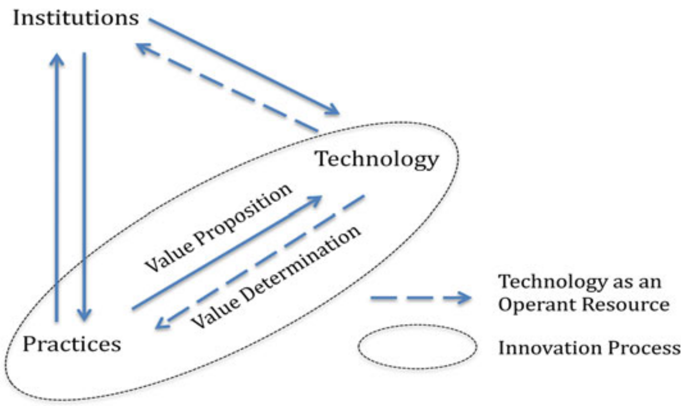

Fig. 1 Innovation in service ecosystems (adapted from Orlikowsky 1992; Vargo and Akaka 2012)

5.1 Technology

The framework above is adapted from Orlikowski's (1992) model , which identifies the central drivers of innovation as institutions, technology and human action. In her structurational model of technology, technology can be considered as an operant resource because it influences both institutions as well as human action (via use of a technology). Orlikowski discusses the way in which innovation can occur through the development, design, appropriation or modification of a technology. In this view, technology can be conceptualized as an operant resource because it influences institutions, and subsequently human actions (the inner triangle). For example, when a technology is developed such as the X-ray machine, institutions form as to what the technology is used for and how it works. In this particular case, actors who operate the technology need to acquire highly specialized knowledge and skills, but others who benefit from the service an X-ray machine provides (e.g., identifying broken bones) do not. Institutions guide the understanding of how the technology can be applied, but also influence how the technology can be improved and used in novel ways.

The application of this model in an S-D logic, ecosystems framework, draws attention toward how value is co-created through human efforts to integrate resources and how changes in resource integration practices also influence institutions, and subsequently the way in which we use and/or evaluate a particular technology. From this perspective, innovation not only develops through design and modification, but also emerges through less deliberate actions that integrate resources in new or different ways (Arthur 2009). In this way, technology also can be conceptualized as an operant resource because it influences the way in which value is determined. However, as a particular technology is integrated with other resources value is uniquely and phenomenologically determined and as technologies are repeatedly combined or integrated with other resources (i.e., innovation occurs), new institutions (e.g., social norms) form. These institutions then influence the way in which technologies are used and the value of a particular technology is determined (outer triangle). In the case of the X-ray, recent applications of this particular technology can be seen in airports around the world. Rather than using the X-ray technology as a means for detecting broken bones, for example, this technology an be used to detect harmful devices carried by travelers. By applying the same technology in a different context, the X-ray technology can be used for both health and safety purposes.

Based on this framework, *technology can be conceptualized as a set of practices and processes, as well as symbols, that contribute to value creation or fulfill a human need*. Any given technology is embedded in an ecosystem composed of a various practices, processes and institutions. Although the process of innovation occurs through both value proposition and value determination phases, or design and use (Orlikowsky 1992), these processes are nested within service ecosystems composed of multiple institutions and practices. Thus, in order to understand how new forms of creating value emerge and innovation occurs, practices, processes and institutions must be explored as well.

5.2 Practices and processes

The consideration of technology as an operant resource in service ecosystems contributes to the understanding of value co-creation at both individual and collective levels. From an S-D logic, service ecosystems view, when technology arises as a product of deliberate human action, it is considered as a value proposition because it is developed for a specific purpose, or to solve a particular problem, often in a unique context. However, in line with Orlikowsky's (1992) duality of technology, S-D logic's foundational premise that value is always phenomenological (Vargo and Lusch 2008) suggests that the value proposed through the development of a technology is not necessarily the value derived from that same technology. This is because there is a disjuncture between the design and use of any technology. Orlikowsky (1992) recognizes the difference between the design and use of a technology as "interpretive flexibility." With regard to the use of technology in organizations, Orlikowsky (1992) argues that "the interaction of technology and organizations is a function of the different actors and socio-historical contexts implicated in its development and use."

One of the main differences between Orlikowsky's (1992) view on the role of technology in organizations, and an S-D logic, ecosystems view is the consideration of the context within which technology is used and/or designed. Orlikowsky (1992) argues that "once developed and deployed, technology tends to become reified and institutionalized, losing its connection with the human agents that constructed it or gave it meaning, and it appears to be part of the objective, structural properties of the organization." However, an ecosystems approach for studying service systems emphasizes the need to oscillate perspectives among micro, meso and macro levels of both structures and systems (Chandler and Vargo 2011). Furthermore, the ecosystems approach emphasizes systems of service systems, and draws attention toward multiple systems and structures that share, exchange and integrate information, technology and institutions as resources. This provides a broader view of technology and suggests that it is unlikely that a particular technology is ever fully detached from its originating source. Rather, the norms and meanings that guided the development of a given technology often remain connected to a technology as it is used, albeit in different, unique ways.

It is in this way that the feedback from alternative practices associated with the use of a particular technology can be reconsidered, and technologies reinvented. From this ecosystems view, the process of innovation spans both development and use phases (Orlikowsky 1992) and processes of value co-creation are iterative and continuous. Importantly, a service ecosystems view underscores the differences in perspectives and practices in value co-creation within and among service systems. The discrepancy between design mode and use mode (Orlikowsky 1992) is the difference between the value proposed and value determined through a particular context. Because, in this view, technology is considered as both a process and an outcome, both the proposition and determination of value contribute to the co-creation of value-in-context as well as new ways of creating value, or innovating service.

This view has important implications for service innovation because it suggests that although value determined through use is often different from that which is proposed, technology is rarely completely severed from its originating institutions. Although a technology can be applied in a different context, the institutions that guide the way in which it is used remain. With regard to the X-ray example discussed above, although the technology has specific purposes in each context—i.e., health care in hospitals and safety in airports, schools and other public places—the institutions guiding the use of the technology remain. In order for X-ray technology to be applied in the airport setting, actors (people, firms, passengers) needed to be familiar with the technology and how to use it. In this way, it is clear the alternative applications of a particular technology can be considered as inputs, as well as outcomes, of the (re)design mode. Because value co-creation is iterative and continuous, changes in technology are inevitable.

5.3 Institutions

Institutions are an important component of service ecosystems because they enable and restrain the actions and interactions of actors and influence the derivation and determination of value that emerges out of those interactions. Service ecosystems are composed of sub-ecosystems with multiple institutions that intersect and overlap at micro, meso and macro levels of social interactions (Chandler and Vargo 2011). This view of overlapping institutions also aligns with Spohrer and Maglio's (2010) recent recognition of the importance of symbol manipulation across service systems. This is because when institutions become integrated as resources with other institutions, symbols are re-interpreted based on new contexts, and new meanings emerge.

With regard to technology, this suggests that as a particular technology is integrated as a potential resource into a new service system, the institutions of both external and internal systems will be integrated as well. The integration of multiple institutions helps to determine the value of a particular technology—what Spohrer and Maglio (2010) call "the process of valuing"—that is integrated in a particular social context. This view of institutions as a resource suggests that it is not only the configuration of the network of actors, or position (or influence) of a particular actor, that contributes to the spread of an innovation (Rogers 1962), but it is also the institutions that guide the acceptance or rejection of a particular technology. Importantly, this consideration of integrating institutions and technologies as operant resources helps to explain why some technologies fail in particular social contexts (e.g., cultures) and thrive in others.

In this view, the development of a new or improved technology (combination of practices, processes and symbols) does not ensure that innovation will occur. This is because a particular combination of practices, processes and symbols (i.e., a technology) may not be considered as a resource, or a resistance, in a particular service system. This may be the case when particular technologies are introduced into new cultural contexts (e.g., international exchange), or when a new offering fails in a particular market. In this service-ecosystems view, in order for innovation to occur, a particular technology must be determined as valuable, through use, in that particular context. In other words, based on our definition of technology proposed above, *innovation can be conceptualized as the recombination of a set of practices, processes and symbols to serve a human purpose*, but this recombination occurs through *both value proposition and value determination phases*.

6 Implications and conclusion

This research conceptually explores the role and scope of technology in value co-creation and service innovation. Drawing on the structurational model of technology (Orlikowsky 1992), it is clear that technology is an important aspect of service provision, value co-creation and service innovation because it is both a medium and an outcome of human action. Although this model helps to explicate the role of technology in value creation, its view on the scope of technology as a material artifact, or an "output" of human action, limits the application of this model in dynamic systems of service-for-service exchange (i.e., service systems). To extend the scope of technology and to consider the practices and processes (Arthur 2009) associated with value co-creation and service innovation, we have applied an S-D logic, service ecosystems view (Vargo and Lusch 2004, 2008, 2011a) and propose a model for service innovation that is based on the conceptualization of technology as an operant resource. This ecosystems approach broadens the scope of technology and suggests that innovation involves the institutionalization of a set of practices, processes and symbols.

This extended view on the nature of technology helps to provide a more encompassing framework for considering the role of technology in value co-creation as well as service innovation. In this view, value co-creation continues through both the design and use phases of technology and service innovation is driven by iterative processes of collaboration and learning between service providers and service beneficiaries. Thus, innovation is not limited to the development of new (tangible or intangible) products; rather, innovation is driven by the co-creation of value and unique perspectives of how to apply and integrate resources. Importantly, as discussed here, this shift in thinking about processes, rather than products, requires the reconsideration of the scope and the role of technology and how it is developed and used within and among service systems. Based on this structurational and service-centered view, technology is considered as the means of innovation, as well as the outcome. In other words, rather than thinking about innovation as the process by which new technologies are developed, this framework suggests that as technologies (practices and processes by which value is created) become recombined with other resources, including technologies, innovation occurs.

This shift in thinking about technology as an operant resource requires further elaboration and investigation. This framework provides a means for systematically exploring innovation by studying changes in practices and processes of multiple stakeholders and how they lead to the development of new means for serving human purposes, or ways of creating value (i.e., new technologies). The consideration of technology as an operant resource suggests that the study of innovation requires the consideration of both design and use modes, or phases, as well as the iterative processes of learning and improvement and the institutions that guide them. Furthermore, an ecosystems approach to studying value co-creation and innovation requires a perspective that oscillates among micro, meso and macro levels of analysis. In other words, to best understand how value is co-created and innovation occurs, researchers should examine interaction and value determination at and from multiple levels, as well as the relationships among those levels (Chandler and Vargo 2011; Penaloza and Mish 2011).

The exploration of the role and scope of technology in service ecosystems is just beginning. However, it is a necessary endeavor in order to better understand how to develop new ways of creating value and innovate service. This broader view of technology as an operant resource in (eco)systems of service-for-service exchange provides a platform from which a number of studies can be conducted to better understand the nuances of technology as a dynamic and influential resource, and the role of institutions in value co-creation and service innovation. We hope that this reconsideration of the nature of technology and its role in service (eco)systems will contribute to the ongoing integration of resources and effort to discover new ways of creating value through service-related research, and important innovations will occur.

References

Akaka MA, Chandler JD (2010) Practices, processes, positions and propositions: a resource-based approach to value co-creation in value networks. Forum on Markets and Marketing, Cambridge, UK

Akaka MA, Vargo SL, Lusch RF (2012) An exploration of networks in value co-creation: a service-ecosystems view. Review of Marketing Research, vol 9, pp 13–50

Andersen B, Metcalfe JS, Tether BS (2000) Distributed innovation systems and instituted economic processes. In: Metcalfe JS, Miles I (eds) Innovation in systems in the service economy: measurement and case study analysis. Kluwer Academic Publishers, Boston

Arthur WB (2009) The nature of technology: what it is and how it evolves. Free Press, New York

Berry LL, Parasuraman A, Zeithaml V (1994) Improving service quality in America: lessons learned. Acad Manag Exec 8(2):32–52
Bitner MJ, Zeithaml VA, Gremler DD (2010) Technology's impact on the gaps model of service quality. In: Maglio PP, Kieliszewski JA, Spohrer JC (eds) Handbook of service science. Springer, New York, pp 197–218
Chandler JD, Vargo SL (2011) Contextualization and value-in-context: how value frames exchange. Mark Theory 11(1):35–49
Constantin JA, Lusch RF (1994) Understanding resource management. The Planning Forum, Oxford
Coombs R, Miles I (2000) Innovation, measurement and services: the new problematique. In: Metcalfe JS, Miles I (eds) Innovation systems in the service economy: measurement and case study analysis. Kluwer Academic Publishers, Boston
Drejer I (2004) Identifying innovation in surveys of services: a Schumpeterian perspective. Res Policy 33:551–562
Drucker P (1985) The discipline of innovation. Harv Bus Rev 63(3):67–72
Edvardsson B, Tronvoll B, Gruber T (2011) Expanding understanding of service exchange and value co-creation: a social construction approach. J Acad Mark Sci 39(2):327–339
Gallouj F, Savona M (2009) Innovation in services: a review of the debate and a research agenda. J Evol Econ 19:149–172
Giddens A (1984) The constitution of society. University of California Press, Berkley
Gummesson E, Gronroos C (2012) The emergence of the new service marketing: nordic school perspectives. J Serv Manag 23(4):479–497
Hart C (1988) The power of unconditional service guarantees. Harv Bus Rev 66(4):54–62
Hunt S (2002) Foundations of marketing theory: toward a general theory of marketing. M. E. Sharpe, Armonk
Lusch RF, Vargo SL (2006) The service-dominant logic of marketing: dialog, debate and directions. M. E. Sharpe, Armonk
Maglio P, Spohrer J (2008) Fundamentals of service science. J Acad Mark Sci 36:18–20
Michel S, Brown SW, Gallan A (2008) An expanded and strategic view of discontinuous innovations: deploying a service-dominant logic. J Acad Mark Sci 36:54–66
Normann R (2001) Reframing business: when the map changes the landscape. Wiley, Chichester
Ordanini A, Parasuraman A (2011) Service innovation viewed through a service-dominant logic lens: a conceptual framework and empirical analysis. J Serv Res 14(1):3–23
Orlikowsky W (1992) The duality of technology: rethinking of the concept of technology in organizations. Organ Sci 3(3):398–427
Penaloza L, Mish J (2011) Leveraging insights from consumer culture theory and service dominant logic: the nature and processes of market co-creation in triple bottom line firms. Mark Theory 11(1):9–34
Prahalad CK, Ramaswamy V (2004) Co-creating unique value with customers. Strategy Leadersh 32(3):4–9
Preissl B (2000) Service innovation: what makes it different? Empirical evidence from Germany. In: Metcalfe JS, Miles I (eds) Innovation systems in the service economy: measurement and case study analysis. Kluwer Academic Publishers, Boston
Rogers E (1962) Diffusion of innovations. The Free Press, New York
Rust R (2004) If everything is service, why is this happening now, and what difference does it make? J Mark 68(1):23–24
Spohrer J, Maglio PP (2010) Toward a science of service systems: value and symbols. In: Maglio PP, Kieliszewski JA, Spohrer JC (eds) Handbook of service science. Springer, New York, pp 157–194
Sunbo J, Gallouj F (2000) Innovation as a loosely coupled system in services. In: Metcalfe JS, Miles I (eds) Innovation systems in the service economy: measurement and case study analysis. Kluwer Academic Publishers, Boston
Vargo SL, Akaka MA (2009) Service-dominant logic as a foundation for service science: clarifications. Serv Sci 1(1):32–41
Vargo SL, Akaka MA (2012) Value co-creation and service systems (re)formation: a service ecosystems view. Serv Sci 4(3):207–217
Vargo SL, Lusch RF (2004) Evolving to a new dominant logic for marketing. J Mark 68(1):1–17
Vargo SL, Lusch RF (2008) Service-dominant logic: continuing the evolution. J Acad Mark Sci 36(1):1–10

Vargo SL, Lusch RF (2011a) It's all B2B…and beyond: toward a systems perspective of the market. Ind Mark Manag 40(2):181–187

Vargo SL, Lusch RF (2011b) "From goods-dominant logic to service-dominant log-ic," invited presentation at workshop on service-dominant logic: an evolution or rev-olution in marketing theory and practice? Hosted by Concordia University, Montreal

Vargo SL, Maglio PP, Akaka MA (2008) On value and value co-creation: a service systems and service logic perspective. Eur Manag J 26(3):145–152

Williamson O (2000) The new institutional economics: taking stock, looking ahead. J Econ Lit 38(3):595–613

Zimmerman EW (1951) World resources and industries. Harper & Row, New York