WMG Service Systems Research Group
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Viable Service Systems and Decision Making in Service Management

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The group aims to advance the knowledge of value-creating service systems to help organisations innovate and evolve to new business models and make better decisions in the design, delivery and management of their value propositions to co-create value.

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1. Introduction

This paper addresses decision making in the management of complex service systems, highlighting the contribution of the viable systems approach as an interpretative and governance methodology based on systems thinking.

In the last few decades, business management has undergone significant changes due to rapid developments in markets. New competitive strategies and technologies have stimulated global discussion about business models and tools (Ghoshal, 2005). The role of relationships has become increasingly relevant in businesses, and researchers as well as industries are shifting their focus to a service-oriented approach, moving from a paradigm of product to one of service (IfM-IBM Cambridge SSME Report, 2008).

A service is essentially relational in nature, as it provides assistance and expertise and involves a co-productive relationship within which both providers and clients (actors) are participants in the service exchange (Payne et al., 2008). The notion of service is increasingly becoming related to one of system, resulting in the notion of service system, which is composed of heterogeneous entities interacting with a shared goal. As every service system implies that actors of a service are connected by value propositions in value chains, value networks, or value-creating systems, socio-economic actors (individuals and firms) are engaged within complex service systems, acting in the market to achieve desired outcomes. As such, a critical analysis of the concept of service system stimulates a discussion about Complex Service Systems.

This paper aims to discuss the implications of attributing a 'complex' nature to service systems. It will note how service research has failed to fully capture the inner nature of service systems complexity, due to the failure to distinguish the structural and static observation of reality as being complementary to a systems and dynamic view of the same observed phenomenon. This interpretative gap, indeed, may result in a gap in managing and designing complex service systems as attempts to view and manage service organizations as systems fail to adopt and apply the theoretical constructs of systems thinking. In fact, much of the use of the word 'system' in literature merely describe interconnectedness of entities, but do not adhere to systems thinking principles, which often disrupt the traditional thinking. We are convinced that in order to properly interpret and manage service systems, we need to deepen our understanding of the concepts of service, service systems and complex service systems, and adopt insights derived from systems thinking which are intrinsically illuminating to issues emerging when dealing with complexity.

When dealing with complex service systems, the key issue seems to be one of emergence. Systems thinking offers general interpretative approaches to face the open, dynamic and emergent nature of service systems, which may generate complexity. By adopting a systems perspective however, the service system is no longer considered as complex in itself, as complexity characterizes the conditions that decision makers have to face in managing such systems.

While the common use of the term 'complexity' refers to issues that are almost impossible to resolve, its meaning as attributed by researchers from various disciplines has been extended over time, as their investigations quite often take an objective approach. In fact, in management studies the subjective approach to complexity is quite new.

The growing interest in research on complexity is coupled with the recognition that previous interpretative approaches based on predefined and standardized solutions are inadequate for dealing with new challenges that arise in today's dynamic environments. This has led to the quest for more adequate interpretative approaches and to the adoption of systems thinking in business and social economics. In this context, we propose the Viable Systems Approach (*vSa*) as a perspective from which to extract new interpretative approaches for governance in complex situations. By interpreting business and social organizations as viable systems, *vSa* offers general reference schemes to deal with the systemic nature of service and service systems management and its related conditions of complexity.

This paper proposes an interpretation of complexity in the context of service systems, which highlights the perspective change that occurs when adopting a systems approach. Beginning with a review of service management research streams and the concepts of service systems and complex service systems, the paper then proceeds to discuss the contribution of systems thinking in service management, proposing a systems interpretation of complexity and more specifically, the *vSa* as a decision-making methodological approach coherent with the nature of the investigated phenomena. The proposed approach is then brought to an operational level through modeling a service system as a network of agents, resources, processes and decisions, on the basis of fuzzy logic as a robust framework for dealing with complexity in service systems management. The last section concludes the paper with directions for further research.

2. Recent Service Management Advances

In the past few decades, business management has undergone a dramatic change due to competitive behavior and new technologies, stimulating global discussion about traditional business models and tools and prompting a search for new approaches and better performing constructs that are more relevant to real economic contexts (Barile, 2009). This development has been spurred on by globalization, the growing importance of information and communication technology (ICT) and the increased relevance of relationships in business (Håkansson and Snehota, 1995; Gummesson, 2008b).

A Service Economy (Fuchs, 1968) is therefore emerging globally, with growing interest in service(s) and its relevance in all business activities (Normann, 1984; Grönroos, 2000). An increasing number of firms today consider their core proposition to be one of service even if they are still involved in manufacturing, not merely because they offer service activities 'wrapped around' the equipment they manufacture, but also due to increasing recognition of the fact that service and manufacturing activities interact through the design, technology and business value propositions of their offerings (Smith et al., 2012). This has resulted in firms focusing on service logics and basing their competitiveness on service quality performances and service innovation (von Hippel, 2005). As economies increasingly depend on human knowledge and the application of information to create benefits (Spohrer et al., 2007), the concept of 'service' has come to dominate theoretical models, enterprise strategies, corporate governance, decision-making processes, and many business and social relationships.

Researchers began to explore the area of service(s) from the early 1970s, generating various service management research streams within which service marketing is one of the most prolific, along with operations management, human resource management, quality management and various others (Grönroos, 2000; Lovelock and Wirtz, 2010). In this area, European scholars particularly the Nordic school played a prominent role in investigating the differences between goods and services and finally proposing a general service perspective for any business proposition (Wyckham et al., 1975; Eiglier and Langeard, 1987).

In this research stream, a key role is played by relationship marketing researchers (Grönroos, 2000) and their progressive focus on B2B, B2C, CRM (Grönroos, 2000), many-to-many marketing (Gummesson, 2008a) and networks (Håkansson and Snehota, 1995; Christopher et al., 2002; Håkansson et al., 2009). Table 1 provides a summary of recent concepts of 'service'.

Table 1: Summary of recent concepts of service

Recent Proposals of the ' Service' concept	Main Focus	Author/Year
Application of specialized competencies	Value enhancement	Vargo and Lusch (2004)
Activity providing assistance/expertise	Solution finding	Gronroos (2008)
System of interacting parts	Competitive advantage	Maglio and Spohrer (2008)
Acts performed for others	Resource valorization	Alter (2008)
Work performed for others' benefits	Provider/user interaction	Katzan (2008)

Source: Barile and Polese, 2010b

A critical analysis of the concepts shown in Table 1 highlights the gradual acknowledgement that service is far from being a mere attribute of what is exchanged (i.e. immateriality); rather, it ought to be a key concept in the design and management of sustainable, profitable and rewarding relationships in every service exchange.

More recently, some service research streams have introduced innovative but disruptive proposals (Barile and Saviano, 2010). This includes the Service Dominant (S-D) logic proposed by Vargo and Lusch (2008), which suggests a paradigm shift in marketing with regards to the determinants of service exchanges. S-D logic shifts the focus from value-in-exchange to a much more challenging (and indeed revolutionary) service perspective of value-co-creation and value-in-use. In this respect, such a theoretical proposal has implications not only for marketing but also from a wider perspective, for organizational studies, public administration, management, economics and social sciences as well as engineering and ICT. In particular, S-D logic provides a powerful trans-disciplinary framework through which service systems could be viewed and managed. According to S-D logic, service is the application (through deeds, processes, and performances) of specialized operant resources (knowledge and skills) for the benefit of another entity, or the entity itself. Emphasis is thus placed on the process of doing something for and with another entity in order to create value. Service thus represents the common denominator of all exchange processes, and goods become mere vehicles for the application of service provision i.e. goods are indirect service provision, a temporal vessel of service, and service is what is always exchanged in the creation of value (Vargo and Lusch, 2008).

Another recent advancement in service research is Service Science (SS), which adopts a systems view of service aimed at developing a wider multi-disciplinary knowledge of service management, engineering and design (Maglio and Spohrer, 2008; Alter, 2008). According to SS, service is seen as a dynamic system of interacting and interdependent parts (people, technologies, and business activities) to create and deliver value, thus achieving and maintaining a sustainable competitive advantage. In emphasizing service systems, SS is thus focused on networks of relationships as the fundamental elements in the concept of service (Spohrer et al., 2007). Therefore in service systems, relationships among interacting systems are based upon a 'win–win' logic and are developed to achieve mutual satisfaction and optimal outcomes for all involved parties (Maglio and Spohrer, 2008).

Although initially generated from a practitioners' perspective, SS has become a new multidisciplinary research endeavor involving computer science, behavioral psychology, organizational theory, industrial engineering, business studies, management sciences, and social sciences. Indeed, SS calls for a scientific collaboration to develop a common service research domain through a unified and shared conceptualization of service exchange (IfM-IBM Cambridge SSME Report, 2008; Gummesson et al., 2009; 2011).

3. Service systems

As research in SS and S-D logic advances, the notion of *service* is becoming more and more related to the one of *system* (with its traditional focus on dynamics, multiple elements/actors engaged in network systems) which in turn leads to the notion of Service Systems, where entities integrate resources for outcomes. Indeed, it is now commonly acknowledged that service system is the basic abstraction of service science (Maglio et al, 2009), and S-D logic the frame within which service systems could be operationalized for value co-creation (Ng, Maull and Yip, 2009). A service system is defined by Maglio and Spohrer (2008) as "a configuration of people, technologies, organizations and shared information, able to create and deliver value to providers, users and other interested entities, through service". This integration of needs, resources, information, and objectives among providers and users stimulates co-creation processes that have now come to dominate the developed economies of the world (Qiu, 2009). The notion of 'service system' has been addressed by many researchers; Table 2 provides a list of recent contributions to its definition.

Table 2: Service System recent definitions

Service System recent definitions	Authors	Year
Service Systems … as value co-creation configuration of people, technology, value propositions connecting internal and external service systems …	Spohrer, Maglio, Bailey and Gruhl	2007
Service Systems can simply be a software application, or a business unit with an organization, from a project team, a business department, a global division	Qiu, Fang, Shen and Yu	2007
Service Systems act as resource integrators …	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.	Spohrer, Vargo, Maglio and Caswell	2008
Service systems can be divided into "front stage" and "back stage" and service performance relies on both of them, putting people, rather than physical goods, in the centre of its organizational structure and operations.	Qiu	2009
Service systems are a complex interplay between form and customer that form an open system which needs to be designed using the techniques of viable systems and systems dynamics…	Ng, Smith and Maull	2011

Source: adapted from Barile and Polese, 2010b

Through the evolving definitions of service systems shown in Table 2, we can see how powerful and robust the concept of service systems is. It spans from a configurational model to a software application, from a provider-client means of interaction to value co-creating interacting models. These service systems definitions highlight the importance of knowledge as a 'meta-resource' (Mele, 2003), suggesting that service systems may be viewed as primarily cognitive systems (Vicari, 1991; Rullani, 2004) in which information and knowledge are the fundamental elements of decision making. As knowledge and competencies are more and more diversified, firms become sets of micro-specializations that must integrate and transform their resources into a higher order of service potential (Vargo and Lusch, 2008) in order to undertake wise decisions and pursue satisfactory behavior. Thus, the four key dimensions of service systems – customers, people, information, and technology (Mele and Polese, 2011) – together with learning processes form the basis of decision making in service systems.

It is within this mainframe that service systems can be interpreted as resource integrative systems, comprehensible in terms of elements of a work system (Spohrer et al., 2007) within an organization which, through a network, takes advantage of resources, both operand and operant (Vargo and Lusch, 2008), such as knowledge, skills, know-how, relationships, competences, people, products, material money, etc. Accordingly, service systems are capable of enabling connections and interactions among all parties involved within a service exchange.

A key issue when dealing with service systems is the notion of service focused on value *co-creation* (Prahalad and Ramaswamy, 2004; Vargo and Lusch, 2008; Lambert and Garcia-Dastugue, 2006) that implies a dynamic interaction among numerous actors in reticular systems (Barile et al., 2012). Thus, the notion of value co-creation is connected to resources integration as an important enabler of service exchange.

Resources integration within the service exchange has intriguing implications on the role of engaged socio-economic actors and their participation in value creation. In this respect, B2B, B2C/C2B, C2C, B2S/S2B, C2S/S2C relationships have been investigated, along with the more recently proposed configuration of A2A (where B stands for Business, C for Customer, S for Stakeholder, A for Actor, and the first letter is the entity that activates the interaction) (Gummesson and Polese, 2009; Polese, 2009; Vargo and Lusch, 2011; Vargo et al., 2012). Hence, from a dyadic conception of service exchange, a value co-creation view widens the perspective, defining a rich, end variegated setting in which multiple actors are engaged in a dense network of interactions. By their inner nature, service systems involve heterogeneous entities, each one with his/her own outcomes, connected by value propositions in value chains, value networks, or value-creating systems and interacting through co-creation in order to converge towards consistent goals.
As shown in Table 2, Sprohrer et al. (2007) define service systems as a "complex adaptive systems made up of people, and people are complex and adaptive themselves. Service systems are dynamic and open, rather than simple and optimized". Building upon this proposal, Qiu (2009) defines service systems as socio-technical systems that place people, rather than physical goods, in the center of their organizational structure and operations, underlining the relevance of the human side of service exchanges. Thus, the most recent contributions to service systems literature focus on several aspects and elements that lead to the use of the 'complex' attribute.

Accordingly, service research approaches the domain of Complex Service Systems (Taylor and Tofts, 2012) as it attempts to increase understanding of the underlying logic in order to effectively stimulate value-creation experiences.

4. Complex service systems

Recently, a dominant interpretative approach of complex service systems research has addressed the complexity of service systems from an engineering perspective, in particular from the prolific research streams focused on Complex Engineering Service Systems (CESS) (e.g. Ng et. al., 2011) and Complex Adaptive Systems (CAS) (e.g. Miller and Page, 2007).

There is a need to acknowledge that a systems view may be required when the complexity of service systems is associated with unmanageability due to the numerous perspectives and expectations of different stakeholders involved in the system's dynamics, and with the nested and recursive relations among "sub-service systems serving both internal and external stakeholders", especially given the need to consider the perspective of all service stakeholders (Cheng et al., 2007).

However, extant research views complexity in two ways; first, by qualifying complex systems as a system of systems, where complexity arises in part from the fact that a service system entity can fill multiple roles in multiple service systems simultaneously (Maglio and Spohrer, 2008). Complexity is essentially associated with increasing interconnections and interdependence among people, businesses, and nations in a globalized world; this notion suggests an interpretation of complexity to be an objective feature of reality. Second, when the focus shifts to service interactions to look for –and understand – unintended consequences (Maglio and Spohrer, 2008), a dynamic interpretation of complexity prevails.

The above described views of complexity appear evident in current service systems research. When considering service systems from a quantitative and/or engineering perspective, researchers in effect implicitly assume the existence of linear relations among the observed variables. Indeed, this is an approach consistent with an analytic mechanistic approach that may fail in interpreting most phenomena within the domain of social sciences, where their implicit assumption seems to be far from reality. The acknowledgement of the limits of a dominant analytic mechanistic approach has directed service research towards a wider systems view for service systems analysis and comprehension, in turn resulting in the need for a multidisciplinary perspective (Spohrer et al., 2007). In this vein, it has been declared that 'Service Science can be seen as an interdisciplinary activity which attempts to create an appropriate set of new knowledge to bridge and integrate various areas based on trans-disciplinary and cross-disciplinary collaboration' (IfM-IBM Cambridge SSME Report, 2008:10).

The adoption of a systems view, however, has led to the recognition of a key element in analyzing complexity in service systems, that is: a full specification of an entire system often fails to consider the implications related to interactions that could result in unpredictable emergent properties (Prencipe et al., 2003; Ng et al., 2009; Ng, Guo and Ding, 2011).

Thus, "service systems are indeed complex, especially due to the uncertainties associated with the human-centered aspects of such systems" (Tien, 2008: 385), and the emergence of unexpected outcomes seems to be a key issue in complex service systems, one that ought to be better addressed by service researchers.

A deeper look at complex service systems also highlights another key research focus, particularly with the observation of how different control mechanisms may be in service systems and their intrinsic complex nature due to openness, multi-agents, value co-creation, dynamism and emergence (Badinelli, 2000). In this respect, the main contribution of a systems approach lies in offering several general interpretative approaches towards dealing with the open, dynamic and emergent nature of service systems that generate conditions of complexity (Sterman, 2000; Sawyer, 2005).

Complex service systems have been addressed by many researchers and practitioners, but it is only recently that they are beginning to acknowledge the non-linearity and emerging traits characterizing complex service systems, thus abandoning a merely quantitative and technological view of their complex nature. Among these, Neely, McFarlane and Visnjic (2011) have identified 12 features that can be attributed to complex service systems, some of which are inclined to perceive the dynamics of their essence, such as: risk (risk changes correlated to contractual obligations through time), value in use (how value is perceived by customers), value co-creation (due to the client's active role), and contracting (due to outcome-based contracting).

In illustrating the key properties of service systems, Polyvyannyy et al (2008) use the concepts of diversity, complexity, dynamism, and value creation as features leading to their proposal of a *Flexible Service Systems* in search of systems capable of facing the increasing conditions of complexity in current scenarios. The topic, however, is strongly debated within service research (Ng et al., 2012) and analyzed by Miller and Page (2007), who highlight how much complexity is related to the intrinsic features of Service Systems.

Researchers have argued that "complex behavior arises from the way the parts of the system are interconnected not because the components of the system are themselves complex, although our components, being people and firms, are indeed complex themselves because they are also complex adaptive systems" (Wilkinson, 2006). They also ask themselves "how can we model something complex as a service system, taking account of all relevant interactions among all its parts?" (Maglio, 2011:i). From our perspective, the answer lays in the modeling of all emergent and unexpected intra- and inter-systems interactions; that is to say, we need to adopt a systems thinking approach.

5. Systems thinking contributions in service management

The basic assumption of our reflection is the systemic nature of service systems, which stimulates the adoption of systems theories and therefore compelling the need to capture and apply their intrinsic systemic features within service systems (Ng et al., 2012). Nevertheless, we are convinced that we cannot manage service systems well when the concept of system is used weakly (Ackoff, 2010) Consequently, we aim to deepen the above described concepts of service, service systems, and complex service systems by utilizing some insights derived from using a systems thinking lens.

The earlier discussed trend towards a paradigm shift in marketing has led to a conceptualization of service as the embodiment of co-creation processes among engaged actors who play active roles in integrating resources. Hence, co-creation is fundamental in the new concept of service. This attention on the process underlines the dynamic nature of the service exchange as characterized by interactions involving numerous actors co-creating value in the market exchange (Boulding et al., 1993).

Indeed, since its introduction within service research, the concept of value co-creation has taken root, due to its attempt to demonstrate aspects of the service exchange that are truly systemic in nature. The acknowledgment of the limits of the traditional transactional view of exchange, primarily based upon dyadic relations (Gummesson, 2008a), has in fact generated a move from value as being delivered (essentially based upon a producer-consumer relationship) to value as being co-created (essentially based upon many-to-many interactions). The engagement among many actors in a co-creation context renders value to be conceptualized as an outcome that is inherently emergent and contextual (Ng, Guo and Ding, 2011; Ng and Smith, 2012). Yet, the notion of co-creation appears to be tricky and difficult to define, and is often analyzed without recognizing its systemic nature nor by adopting a systems thinking approach. The attention given to concepts such as process, dynamics, interaction, multi-actor participation, co-creation, etc. has led to a weightier *system* qualification of service exchange, although attempts in this direction seem to be at an early stage (Mele et al., 2010).

Undoubtedly, the service scholarly community within the SSME (service science, management and engineering) stream has advanced research in Service Science and Service Systems (Maglio and Spohrer, 2008). However, despite its intrinsic interdisciplinary goal to widen the analysis of Service Systems through numerous knowledge domain perspectives, the research development of Service Systems still seems to be based upon the technology-centric knowledge domain of its founders. In this light, we can observe how a systems approach to service science, more specifically to service systems, is often based on a mechanistic and engineering interpretation of systems, and does not fully capture some key principles needed for the full adoption of a systems thinking view.

Science offers at least two different perspectives to interpret phenomena: reductionism, widely used and implicit in many of the disciplines involved in service science, and systems thinking, which is less commonly used but could potentially offer a different set of insights for research (Ng, Maull and Smith, 2011).

Recently, service research has addressed some key aspects of systems thinking in order to fully comprehend service exchanges and champion multidisciplinary approaches within systems theories (Ng et al., 2009). By tracing back to the origins of service systems in the work of Chase (1978) and Wemmerlov and Hyer (1989), Ng, Maull and Smith (2011) capture the wider perspectives supplied by systems thinking within service management, focusing on the concepts of ‘interaction’, ‘whole’ and the issue of complexity and control mechanism. Recognizing the interpretative potential of systems theory, the authors maintain that employing systems thinking under this context offers the researcher a number of higher level concepts that need to be considered extensively, such as open and closed systems, socio-technical systems, law of requisite variety, viable systems model and systems dynamics (Ng, Maull and Smith, 2011).

Acknowledging the growing interest in systems thinking within service research, an increasing number of service researchers have begun to investigate service ‘systems’ from an engineering viewpoint (Qiu, 2009; Demirkan et al., 2008), while various attempts have been made to analyze service systems from a managerial perspective (Barile and Polese, 2010a; 2010b; Barile and Saviano, 2010; Saviano et al., 2010). In this respect, a systems approach is expected to provide tools “to organize disparate and complex elements as a hierarchical organization under a common purpose” (Mora et al., 2011:153).

Thus, service researchers are becoming more interested in systems research while systems researchers are increasingly interested in service research. These converging interests, as mentioned before, have led both research domains to interweave their perspectives as ‘pillars’ of potentially converging research pathways (Gummesson et al., 2009, 2011; Gummesson et al., 2010) as proposed during the 2009 and 2011 Naples Forum on Service (see www.naplesforumonservice.it).

The adoption of a systems view of a service exchange enables a wider perspective of the service systems research domain, strengthening the capacity to distinguish between a static, objective perspective of service systems and a dynamic, subjective one. This is particularly important as service systems often encompass both the social and the material, resulting in tensions between methodology that could privilege one or the other. Hence, it is in this setting that complexity comes to the fore, highlighting a research gap in the study of complex service systems. In this respect, we should recognize that service systems, for their inner dynamic and emergent nature both as 'service' and as 'systems', have to deal with emerging, unexpected and unknown possibilities of interactions that may lead to conditions of complexity (Qiu, 2009; Barile and Saviano, 2010).

6. A Systems View of Complexity

As service research increasingly focuses its attention on the study of the design and management of complex service systems, it is important to understand how it has addressed the systemic nature of the system, as well as its complexity. We believe that service research has not fully captured the in-depth implications arising from complexity issues in service management, which highlights a research gap that ought to be addressed. With this objective, we will try to answer the following questions:

- *How can we fully theoretically reconcile and articulate the intriguing pairing of the two concepts 'service' and 'systems' within service research?*
- *What does 'complex' mean in a service systems context? What would be the difference between a 'simple service system' and a 'complex service system'?*
- *Within service research, which approaches or models could support the understanding and management of complexity in service systems?*

Although the common use of the term 'complexity' refers to issues that are difficult, or almost impossible to resolve, its technical meaning as defined by researchers from various disciplines has been extended over time, adopting different perspectives (Simon, 1969; Tainter, 1988; Arthur, 1999; Dooley and Van de Ven, 1999; Le Moigne, 2002; Rullani, 2004). Etymologically, complexity derives from the Latin word '*complexus'*, which means 'entwined' or 'twisted together'. Such a definition is interpreted as complex because it needs two or more entities who act like they are joined together. Accordingly, complexity would come from both the distinctiveness of these two components as well as their connection. The duality of entities that creates complexity is therefore their behavior within a system that is both distinct and connected. More entities result in more connections and more heterogeneity in distinctions. Conditions are more complex when entities are themselves systems. Since the entities of a complex system cannot be separated without destroying it, analytical methods that deconstruct the system into its entities cannot be used. As Miller and Page (2007) puts it, one cannot "understand running water by catching it in a bucket".

Thus, the analysis of this literature shows that generally, the interpretative approach to qualifying complexity, which is prevalent in business studies, implicitly refers to quantitative criteria as 'dominant' logics (Dooley and Van de Ven, 1999). However, the quantitative approach, useful in measuring phenomena and interpreting their dynamics to make decisions in stable and predictable conditions, loses its capacity to support decision-making processes in fast-changing contexts characterized by emerging and unexpected interactions. Accordingly, the variety and variability characterizing the evolving context in which the decision-making process is developed, weakens the decision makers' capacity to interpret and comprehend phenomena. Indeed, adopting a quantitative approach in decision making implies a shift from complexity to complication, due to the implicit assumption that the observer is capable of comprehending the investigated reality and identifying and measuring all involved variables. This attempt to quantify the system could therefore reduce it to a system consisting of only the measurable variables, or even known variables only. In turn, this paradoxically results in the 'understanding' of a completely different system, without full elucidation of its ontology or sufficient interrogation of its implicit assumptions. Consequently, the adoption of quantitative models may not be the most suitable solution to pursue in the context of complex service systems, as well as in any context characterized by conditions of complexity. These considerations stimulate a deeper interpretation of complexity, an interpretation coherent with its inner nature.

Wearing again the systems thinking lens in interpreting complexity, we present the complexity propositions based on observation perspectives of service systems (Barile and Saviano, 2010, 2011b):

Proposition 1: Different observers of a service system perceive a different level of complexity.
Proposition 2: The 'same' observer, at different systemic states, perceives different levels of complexity.
Proposition 3: Perceiving an event from inside the service system that has generated it is different from observing the event from outside the system itself.
Proposition 4: Structure representation, rather than system representation, induces the perception of different levels of complexity.
Proposition 5: A system is not simple or complex in itself based on its structural features; it is simple or complex depending on the observer's knowledge, capacity and ability to understand it.
Proposition 6: A system is a phenomenon that can generate chaos, complexity or simply complication, depending on the interpretative capacity of the observer (decision maker).

These propositions underline the need for considering the adoption of different possible perspectives when analyzing any observed phenomenon and coherently distinguishing the concepts of:

- structure and dynamics;
- complexity and complicatedness.

6.1 Complexity Perspectives

How can we assume that complexity lies in the observed object and not in the eyes of the observer? Indeed, depending on the observer's capacity to understand and master the key features of the observed reality, perceived complexity levels may vary significantly.

Proposition 1: Different observers of a service system perceive a different level of complexity.

This proposition leads us to believe that perceived complexity, even when attributed to a material object, for example a Rubik's cube, is quite naïve. The Rubik's cube is not complex in itself; rather, it is the process of solving the enigma of the Rubik's cube that may be defined as complex, i.e. the need to juggle with every tassel so that each side is lined up in the same color. On the other hand, it is evident that for anyone merely wishing to play with the cube –and not to have uniform colors on each side– by simply rotating the pieces of the cube in a random fashion, this activity would appear far from complex.

Furthermore, we can assert that the potential level of 'comprehension' that individuals attribute to a specific situation depends on the knowledge they possess when they interact with that situation at a given place and moment in time.

***Proposition 2*:** The 'same' observer, at different systemic states, perceives different levels of complexity.

Evidently, with the evolution of an individual's knowledge patrimony, the level of comprehension attributed to what is observed, can vary.

In addition, it is important to specify whether the perception of the system and its dynamics comes from an observer who is internal or external to the observed system.

***Proposition 3*:** Perceiving an event from inside the service system that has generated it is different from observing the event from outside the system itself.

The space-time perspective taken by the observer based on whether or not he or she is the main actor in the system, becomes a discriminating element with respect to how well he or she will collect and analyze the elements and information useful in dealing with complexity.

6.2 Structure vs. Dynamics

Every system is a whole, and within the whole are its entities or elements. To understand the system, we need to understand the connections that result in the 'whole' system. The notion of 'wholeness', i.e. for all its entities to behave as one, must mean that the whole is composed in a certain way. Structure is therefore the type of connection between the entities of the whole, the way the system is internally organized for the whole. Behavior of entities therefore emerges from structure. However, structure is a static representation of a system that consists of its dynamic 'flows'. In natural systems, structure is the laws of nature while system is the sequence, process and rhythm of the processes of the entities. In social systems such as an organization or a service system, structure is the static description of roles, activities and tasks performed in compliance with rules and constraints, and system is the dynamic movement of activities and actions resulting in the flow of information between entities. In such social systems, a structure can be studied objectively (What is it? How is it made?) whilst a system can only be interpreted (How does it work? What logics does it follow?). This means that from a static structure, the dynamic interpretation of reality brings up the recognition of various possible systems that are dependent on the outcomes that the entities wish to achieve. We therefore propose the following:

Proposition 4**:** Structure representation, rather than system representation, induces the perception of different levels of complexity.

Proposition 4 represents a methodological step forward in the investigation and management of social and business phenomena in service; it introduces a relevant distinction between a perspective based on the observation of elements and features characterizing the structure of the observed phenomenon (structure representation), and a perspective based on the interpretation of its dynamics (systems representation) (Barile and Saviano, 2011a).

6.3 Complexity vs. complicatedness

Complexity does not intervene when the phenomenon becomes more articulated due to an increasing number of components, relations, interconnections, and so forth (structural dimensions of the observed phenomenon). Rather, complexity emerges when the observer (decision maker), in analyzing reality, is forced to abandon the structural perspective and needs to evaluate 'objects', both tangible or intangible, that are (Barile et al., 2012):

- not enumerable on the basis of known calculation criteria;
- characterized by vanishing relational boundaries;
- referred to relationships which change in time and space;
- marked by discontinuous and emergent behavior.

Hence, the decision maker faces conditions of complexity when relations among entities in the phenomenon dynamics, by virtue of the variability of relevant relationships in context, generate interactions that end up being incomprehensible for the most part of the various interacting agents in the system, consequently generating conditions of indeterminacy (Aguiari and Di Nauta, 2012).

As mentioned, all this implies a shift from an objective to a subjective manifestation of complexity that leads to considerations of the following two complexity propositions:

Proposition 5**:** A system is not simple or complex in itself based on its structural features; it is simple or complex depending on the observer's knowledge, capacity and ability to understand it.

Proposition 6**:** A system is a phenomenon that can generate chaos, complexity or simply complication, depending on the interpretative capacity of the observer (decision maker).

However, it is the acknowledgement that it is not the service system in itself that is complex, but the conditions that decision makers have to face in managing such systems particularly in a changing environment, that drives the research focus on systems models and theories coupled with coherent decision-making approaches and control mechanisms.

7. Viable Systems Approach contribution to decision making in service management

We have highlighted how service research can benefit from a systems thinking approach. We have also noted how some researchers have called for its adoption within service research, to accomplish a better understanding of service exchanges (Gummesson et al., 2009; 2011; Ng et al., 2012). While we have proposed systems thinking as an approach to

understanding value co-creation in a service system, it is crucial to also have a methodological approach that is capable of managing its dynamics, its multifaceted and networked nature, and its complexity (Pels et al., 2012). We propose that one such approach is the *Viable Systems Approach* (*vSa*) (Golinelli, 2000, 2010; Barile, 2000, 2009; VV.AA., 2011), an interpretative and governance methodology developed in the last decade in the context of social and business organizations. The *vSa* offers a powerful contribution of systems thinking to both the understanding and management of service systems, as it provides a general framework that takes into account the system nature of service activities and processes. As a consequence, it is useful for interpreting the concept of complexity within service *systems* management, , first by highlighting its systemic nature and then by supporting the investigation of its implications for decision-making in service systems (Barile, 2009; Saviano and Berardi, 2009; Barile and Saviano, 2011b; Saviano and Di Nauta, 2011). We therefore propose that *vSa* may be able to significantly address the earlier identified gap in service systems research and management.
Synthesizing the richness of the concepts, schemes and criteria in the *vSa* can be challenging, but in the next section, we aim to outline the basic elements of *vSa* which we believe to be useful in the context of service systems management.

7.1 The "what" of vSa

Our first step is to clarify a fundamental premise about the scientific positioning of *vSa* and the expected results of its adoption. As its name clearly suggests, the *vSa* is essentially an 'approach' proposing to adopt 'system' thinking interpretative constructs as meta-models for understanding any business knowledge domain such as engineering, management, marketing, etc. It is worth underlining that the *vSa* is not a set of operative 'models to apply' to specific problematic contexts. Rather, it is a general 'method to adopt' in applying a rich number of well-established and consolidated operative models in order to increase their effectiveness in addressing not only problem-solving but also (and mainly) decision-making issues. In adopting a systems thinking perspective, *vSa* identifies 'viability' as the ultimate goal of every systemic entity in competitive contexts. It also proposes a terminological setting capable of representing a coherent theoretical framework of reference for both interpreting and governing the dynamics of social organizations from the perspective of social sciences.

In essence, having recognized the need for a methodological approach to achieve results coherent with the systemic nature and functioning of social and business entities, *vSa* has addressed its efforts towards two directions: to identify the most general principles, axioms and propositions of systems theory and to apply them in a systems model capable of representing the most common features of systemic entities in the context of social sciences.

Towards this aim, the *vSa* takes as its foundation, Stafford Beer's (1972) Viable System Model as an appropriate representation of the structural characterization and systemic functioning of social entities. By updating Beer's original representation to make it suitable for the current business management scenario, the *vSa* has devised a model of the firm as a viable system that can be easily applied to any social entity, be it an individual or an organization.

The key elements of this representation are summarized and applied to the service research domain in the following viable service systems propositions derived from the *vSa* postulates (Barile, 2009; Golinelli, 2010):

Proposition 7: A *viable service system* in a specific context has the main purpose of surviving i.e. staying viable.

Within a service research domain, a viable system could be the context of an ongoing contract where value is co-created between the customer and the firm such as a B2B service e.g. security of a building, equipment-based service (Ng, Maull and Yip, 2009), or it could be a multiple entity service environment such as an airport or a city's transportation.

Proposition 8: The *viable service system* in its ontological representation can be conceived with a dual perspective – that of structure and that of system.

Within the service domain, this means that the system can be represented by mapping its structures which are static in nature, and the systemic flows or movements within the system.

Proposition 9: The *viable service system* in its behavioral dimensions is characterized by the identification of two distinct logical areas: that of decision making and that of operations.

Within a service context, the service behaviors rendered by entities within the system can be the actual value-creating activities i.e. the transformation of material (e.g. equipment repair/maintenance), information (e.g. news reporting), people (hotels) or the management, planning, support and control of such activities.

Proposition 10: The *viable service system*, in its existential dynamics, is conditioned in its pursuit of the final purpose and goals through interaction with recursive sub-systems and supra-systems from which and to which, respectively, it obtains and supplies direction and rules.

Within service research, for every viable system in focus, e.g. the service provision of security of a building, there is a viable sub-system within it e.g. the CCTV network, the guard patrol system. Similarly, there is another viable supra-system above it e.g. building and estate management within which the system in focus lives. This means that for the system in focus (*what* it is), the supra-system dictates *why* the system in focus would exist and the subsystem dictates *how* the system in focus achieves its purpose in a recursive manner, like the droste effect (Nänny and Fischer, 2001).

Proposition 11: For a *viable service system*, all the external entities are also *viable service systems*, or rather, components that trace back to *a viable service system* on a superior level.

Within service research, this suggests that as a unit of analysis, from a structural perspective, a system in focus needs to be clear about what its boundaries are so as to understand what is exogenous (cannot be changed/controlled) and what is endogenous (what can be changed/controlled), and what are the supra- and sub-systems that would dictate the scope of analysis for the whole system in focus.

We are firmly convinced that the scope of these propositions, which is the application of the *vSa*, can be applied to the interpretation and management of social and business organizations in service contexts, thus effectively addressing the methodological gap described in the previous sections of the paper (for further reading on *vSa* literature, see Golinelli, 2000, 2010; Barile, 2000, 2009; VV.AA., 2011). In summary however, *vSa* can be qualified as an approach rooted in systems thinking, based on an updated adoption of Beer's (1972) Viable System Model where both individuals and social organizations can be viewed as viable systems, i.e. open systems aiming to survive in their context by dynamically interacting with all relevant entities that offer resources critical for their function and viability. Indeed, a viable system satisfies three fundamental systemic conditions:

- (partial) openness; the ability to exchange, in a selective way, resources with the systems of the context;
- contextualization; the search for viability through interaction with certain privileged entities, such as supra-systems that influence its survival;
- dynamism; the development of the structure in coherence with emerging challenges.

In the next sections, we will focus on more specific implications in service systems that highlight the *vSa*'s explicative and normative potential for decision making from both a research and a management perspective.

7.2 The "why" of vSa

The *vSa* was developed within the disciplinary field of business management from the early works of Barile (2000) and Golinelli (2000), and has followed a rich research stream of system theories such as open and closed systems (von Bertalanffy, 1968), socio-technical systems (Emery and Trist, 1960), the law of requisite variety (Ashby, 1958), and systems dynamics (Forrester, 1994), with the contributions of Italian researchers in search of a methodological approach to the investigation and governance of business and social organizations as partially open, contextualized, dynamic systems. We propose that the *vSa* represents an appropriate approach towards analyzing socio-economic contexts that are characterized by conditions of non-linear relations. More particularly, the *vSa* provides a robust theoretical foundation from which a whole service system could be analyzed and understood in adherence to systems thinking principles, and yet offers a sufficiently concrete framework for diagnosing, intervening and managing the system in a holistic manner.

In addition, as argued in section 6.2, the main contribution of the *vSa* in addressing the interpretation of complexity is in its paradigmatic distinction between a structure-based and a systems-based perspective (Barile and Saviano, 2010, 2011a). This interpretative approach was developed from distinguishing between a static and a dynamic perspective, and has the merit of allowing for subjective and interpretative perspectives rather than approaches which are static and 'objective' (mono-perspective) that have effectively dominated service research. It also has various expressions in the analytic logic of mechanicism and reductionism while achieving the synthetic logic of systems thinking.

In this sense, the *vSa* lies between a reductionist and a holistic approach (see *vSa* FC3, Barile and Polese, 2011). Indeed, we argue that while reductionist systems and holistic approaches are useful, they need to be adopted coherently with the nature and features of the investigated service systemic phenomenon.

7.3 The "how" of vSa

The *vSa* proposes itself as a methodological framework that is useful for analyzing and governing business and social system's dynamics. This is done by adopting logics of adjustment, transformation, restructuring and redefinition of a system's traits in coherence with the trends and expectations of a fast-changing environment from which conditions of complexity continuously arise and challenge the decision-making process (see *vSa* FC10, Barile and Polese, 2011). We propose that the crucial element of the definition of a service system is the intrinsic goal of achieving outcomes from value co-creation.

Supra-systems and sub-systems

Despite the simplicity of value co-creation's theoretical implications, its goal is far from easy to accomplish. Value co-creation, in fact, implies dealing with multiple actors, each with his/her own goal/perspective. Thus, from a *vSa*, a service system may be a viable system that strives to direct multiple perspectives towards a common and shared goal (see *vSa* FC1, Barile and Polese, 2011). The clear identification of a service system's goal, in particular, enables the definition and selection of the resources needed for the system's effective functioning. Indeed, these resources are owned by actors that need to be engaged within the system to gain access rights to their own resources (Maglio and Spohrer, 2008). In *vSa* terms, this coordination of efforts invokes the role of supra-systems (see *vSa* FC2, Barile and Polese, 2011).

In this respect, the contribution of the *vSa* clearly arises from the fact that it indicates the correct relational relevance of each supra-system through the Supra-systems' Relevance model (Golinelli, 2010). Indeed, this model is useful for representing the supra-systems (actors) relevance map in terms of how critical their resources, and their capacity for influencing the systems dynamics, are. In the context of service systems management, this model enables the correct identification and definition of the behavior that is useful in gaining the so-called 'access rights' to resources (Spohrer et al., 2007).

Consonance and Resonance

According to the *vSa*, the term 'consonance' refers to the potential compatibility between systems elements; it thus refers to a static vision of a potential harmonious relationship. For system survival, real systemic harmony needs to be achieved as 'resonance', which refers to elements operating in a distinctive fashion for a single purpose (see *vSa* FC7, Barile and Polese, 2011). Drawing again on the dualism between 'structure' and 'system', resonance is thus a harmonious systemic interaction, whereas consonance is structural and relational.

Hence, the *vSa* emphasizes the system's ability to foster relationships through dynamic and harmonious interactions, based on the notions of consonance and resonance. This is closely aligned with the concept of value co-creation in S-D logic, which basically refers to a process in which all actors need to be satisfied in a mutual win-win interaction. However, despite the importance of relationships in both S-D logic and SS, this paradigm does not explicitly address the issue of how these relationships can be managed for the benefit of all actors. From a marketing perspective, *vSa* concepts of consonance and resonance represent the potential and realized competitive strategies employed by every successful actor in search of resources and harmonious relationships with other actors in their network.

This relational focus of *vSa* traces the evolution of marketing research, starting from the traditional mainstream research represented by customer relationship management (CRM), total quality management (TQM) and relationship marketing to more recent research endeavors such as many-to-many marketing (Gummesson, 2008b) and A2A market relationships (Vargo and Lusch, 2011).

Decision Making

While correctly focusing on value co-creation as the key concept of service management, recent service research proposals do not closely examine how to manage the articulated network of relations in order to ensure every actor's convergence towards a shared goal as a key process of co-creation. In this respect, the *vSa* underlines the necessity for multi-criteria decision support systems that aim to reach satisfactory conditions for the involved decision makers in search of consonant and resonant interactions among systemic actors (Polese and Di Nauta, 2012). Hence, *vSa* would be useful as a support for the improvement of service management, driving the conciliation of the efficiency of the structure with the effectiveness of the system development under an overall view of sustainability (Saviano et al., 2010; Barile et al., 2011; Siano et al., 2011).

Faced with increasing conditions of complexity, the decision maker cannot fully comprehend the emerging interactions, identify the variables or their expected cause-effect relationships, consequentially falling into the disorientation of indeterminacy and facing conditions of complexity (Saviano and Di Nauta, 2011). Decision-maker rationality is based on the potential to accurately calculate the weight and outcome of certain options selected among the range of available opportunities. Yet, as argued, in service systems dynamics a decision maker's rationality may lose its efficacy. Thus, the *vSa* invokes a methodology from SS to model the decisions to be undertaken by actors in a service system. These models must accommodate not only uncertainty and variety that is imposed by complicatedness, but also vagueness and ambiguity in the specification of the decision that is imposed by complexity. In the next section, we propose the use of fuzzy models for this purpose.

8. Modeling complex service processes within a Viable Service System

The *vSa* has much to offer as an over-arching, theory-generating perspective on service systems (Ng et al., 2012). We note in this section that this perspective can be brought to an operational level in spite of the complexity of the decisions that drive a viable system. We begin by positing that the structure and processes of a viable system can be modeled as a network of agents, resources, processes and decisions. Figure 1 shows the elemental structure of this network.

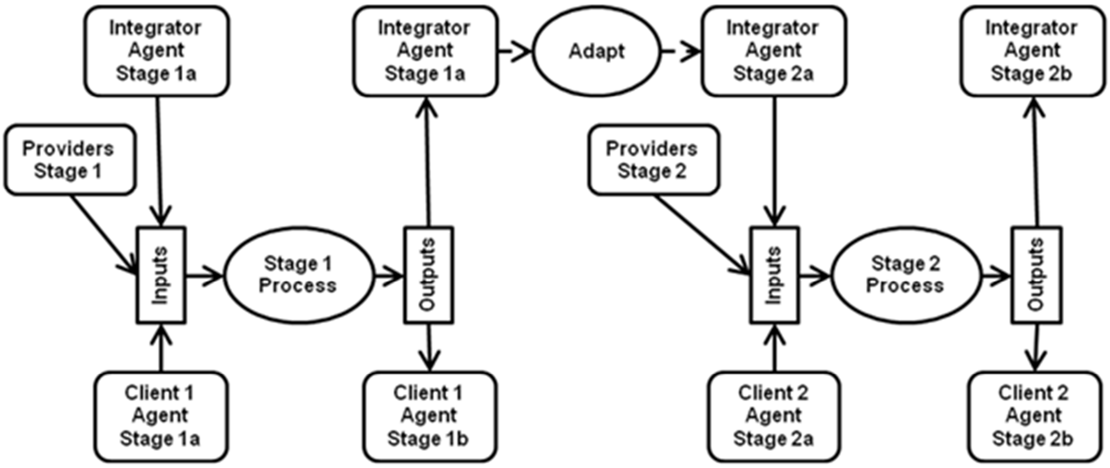

Figure 1: Service system network

8.1 Decision Models

A robust model of a service system calls for a broad interpretation of the term 'agent', which we define as an independent, intelligent and willful actor (not necessarily human) that has access to some relevant resources. Agents can be individual persons, groups of people, firms, government agencies, decision-support systems and combinations of these entities. The service engagement then is a process that transforms a set of input resources into a set of output resources from which participating agents extract value. In order to specify and evaluate the utility of these resources in a context-specific service process, the agent must be guided by a model of the transfer function of the process, which describes the relation between resource inputs and resource outputs. Using such models after each engagement in a service process, each of the participating agents must decide whether or not to continue the service through an ensuing engagement and on the combination of agents and resources who will participate in this process.

In order to be a viable system, an agent must navigate an adaptive trajectory of resource-integrating processes through a service-system network. Viability will depend on the ability of the agent to learn from the experience of previous engagements and to refine the models of potential service processes. However, as service processes are context-specific and innovative, these models cannot be expected to be completely specified or accurately parameterized.

Decision modeling has a long and successful history, beginning with the introduction of linear programming (Golnam et al, 2011). However, all of the well-known forms of decision models that the field of operations research has produced offer decision support for complicated decisions, but not for complex decisions (Badinelli, 2000). A contribution that we can make here is a clear distinction, from a mathematical modeling point of view, between a model of a *complicated system* and a model of a *complex system*. A model of a complicated system is based on a set, possibly very large, of well-defined variables, parameters and performance measures as well as a set of well-defined cause-effect relations from decision variables and parameters as causal factors to performance measures as evaluative factors. The inability to accurately measure all of the factors is met by the use of stochastic versions of such models. See Badinelli (2010) for an example of a stochastic resource-integration model applied to the service-commitment decision.

Stochastic models are well-established as powerful decision-support tools. A stochastic model is based on the assumption that uncertainty is associated with well-defined parameters and can be measured in terms of probability distributions. Stochastic models can represent complicated decisions, but not complex decisions. Stochastic models apply to the inability to accurately measure well-defined parameters and performance measures. Complexity arises from the inability of a modeler to precisely define the variables, parameters and performance measures that are involved in a service process. Complex systems exhibit emergent properties that arise from interactions not captured by the specification of variables and parameters of a complicated system.

8.2 Fuzzy Models

As previously explained, context-specific service processes, by their nature, are ill-defined to the agents who must make resource-commitment decisions. These decisions must be made through the use, either formally or informally, of vague and ambiguous definitions of the resource inputs and resource outputs of a service process and of the transfer function between these sets of resources.

In most cases, an agent must make engagement and resource-commitment decisions with incomplete knowledge of the exact form of resource requirements and of the value of the outcomes of a proposed service process, which leads to perceived risk in the value creation of the service (Barile and Polese, 2010a).

For example, a firm that provides educational programs to individuals who seek to improve their job-related skills is faced with the challenge of designing customized programs for each client. In doing this, the firm, operating as a viable system, must evaluate the client's ability to achieve the educational objectives of a prescribed program through the integration of the client's current education level, skill level and commitment level with the firm's provision of learning materials, classes, exercises, etc. This evaluation cannot be precise, because resources such as the client's skill level and commitment level are not well-defined. However, the firm does not have to renege on its promise to design its offering for the client through an objective, scientific approach that applies all of the knowledge that is available to the firm. The use of fuzzy modeling can be supportive of formalized decision-modeling of agents in such conditions of indeterminacy (Tsoukalas and Uhrig, 1997; Ross et al., 2002; Liu and Lin, 2006).

Vagueness in a fuzzy model measures the degree of imprecision through the use of membership functions in a manner that is similar to the measurement of ignorance or inaccuracy through the use of probability distributions in the case of a stochastic model. Returning to the example of designing an educational program, Figure 2 shows a typical set of membership functions for representing the eight vaguely defined skill levels of a client based on the client's composite score on examinations from previous training processes. From these membership functions, a composite score of 2 definitely indicates that the client's skill level is low, but a composite score of 3 could be considered as an indication of either low or medium skill level. The ambiguity stems from the fact that skill level is only vaguely understood by the firm. See Tsoulakis and Uhrig (1997) for a full explanation of the construction and interpretation of membership functions.

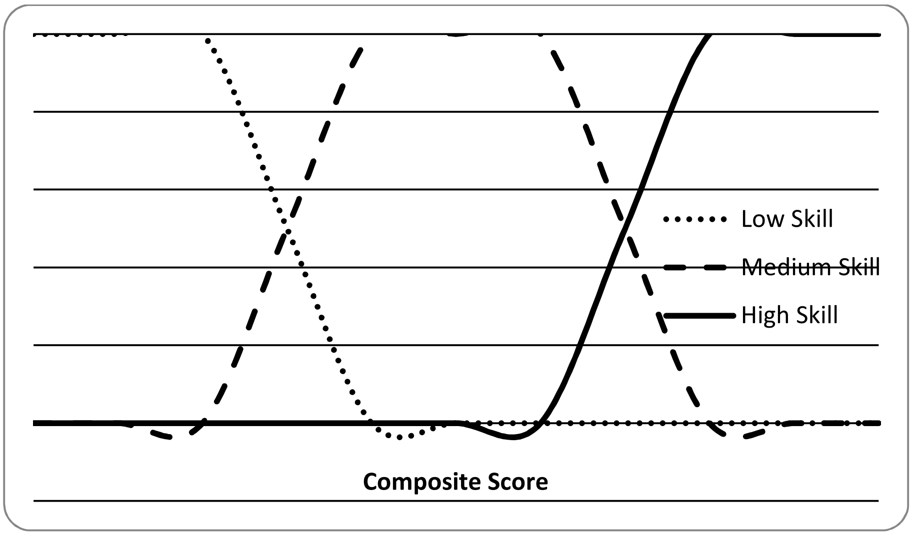

Figure 2: Membership functions of skill level based on composite scores

Similar functions can be constructed for all of the resource inputs, resource outputs and value of any proposed educational process. In addition, the imprecisely-known relationship between these inputs and outputs can be represented via relation-based membership functions. In defining the membership functions of the fuzzy model, the firm reflects its interpretative schemes and categorical values (Barile, 2009; VV.AA., 2011). In our example, a proprietary, descriptive model for the performance of any proposed education program for a client can be constructed, which incorporates all of the knowledge and no more than what the firm knows about the program's effectiveness, thereby maximizing the firm's ability to rationally adapt to each client's needs.

8.3 Fuzzy Controller

We now can prescribe an adaptive, fuzzy-logic controller as a robust modeling tool for agents' epistemology and decision making as it interacts with its environment, learns and acts. A fuzzy model's level of precision is adjustable and can be re-calibrated with each acquisition of new knowledge to reflect an agent's passage through the abductive, inductive and deductive stages of learning (Barile, 2009). The fuzzy-logic controller is a form of feedback control system through which new experience and new information is received, filtered, recorded and added to an agent's knowledge base. Such systems are widely used in controlling complex industrial equipment (Tsoulakis and Uhrig, 1997). In the extension of these systems to the support of a viable system in a changing environment, we modify the objective of the system from control to the learning and the adaptation of the resource offerings of the viable system to its clients.

If new knowledge has the effect of confusing an agent's extant interpretation schemes, then the agent will realize that pre-conceived notions of the meaning and value of resource measures are too narrow and undeservedly precise. In facing the next engagement with a client, the agent must recognize that the agent's understanding of the client's needs is vaguer than before. Adjusting the membership functions of the fuzzy model accordingly, the agent's decision-making is supported by a model that will prescribe a more cautious approach as is appropriate for this abductive phase of the agent's epistemology (Barile, 2009; Badinelli, 2010). In a similar manner, the feedback control system will adjust the membership functions of the fuzzy model to reflect increasing precision as interactions with the client continue and the agent goes through the inductive and deductive phases of developing new knowledge that will support the agent's viability. Figure 3 shows a simplified view of the fuzzy controller for a viable system's learning, adaptation and action.

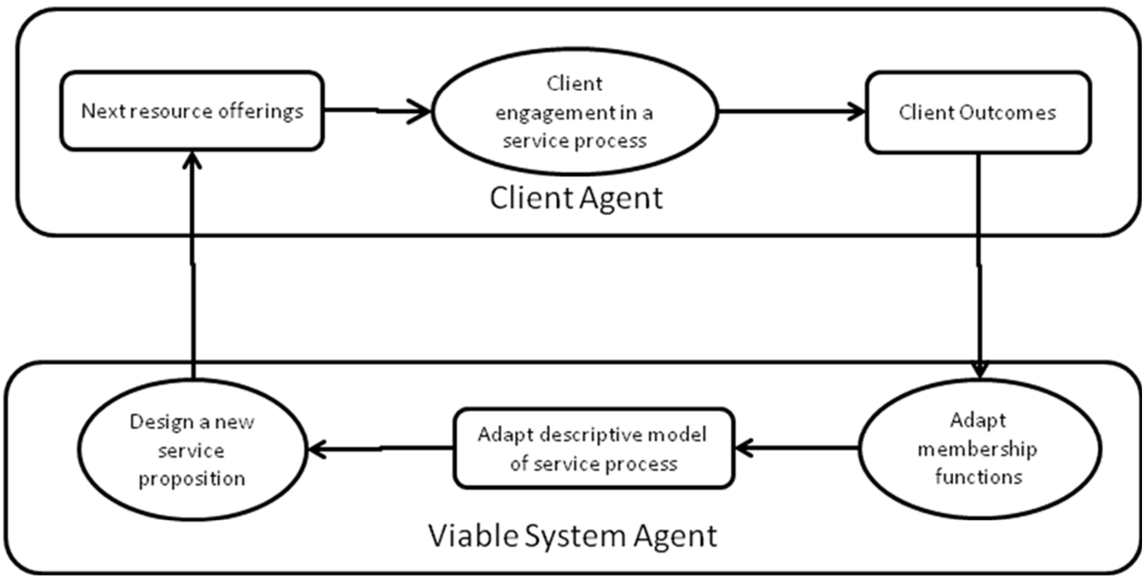

Figure 3: A feedback control system for agent adaptation

Fuzzy modeling is designed for describing complexity and for providing the most intelligent support for making complex decisions. Through this general methodology, we can see a mechanism for achieving the integration of SS with *vSa* and the extension of *vSa* to practical design and management of service systems.

9. Conclusions and implications

The paper introduces advances in service management research that focus on service systems and complex service systems. After arguing that recent research on complex service systems has been based prevalently on a mechanistic-centric view of the issue, and trying to address it with quantitative and reductionistic approaches to the observed phenomenon, the paper introduces a systems thinking view of complexity and of complex service systems. In this light, the *vSa* is proposed as a useful meta-model capable of better supporting service systems decision-making in conditions of complexity. In addition, the paper suggests the adoption of fuzzy models to face the vagueness and ambiguity that characterize complexity contexts.

Implications for future research

Mainstream service research has long taken a reductionistic approach towards service phenomena, using an engineering perspective, often with a mechanistic view of service systems and their complexity. This makes an implicit assumption that the understanding of a phenomenon could be reduced to parts and the insight derived from the understanding of the parts remains the same when the parts are reintegrated with the whole. This could be true if the parts are loosely coupled together and the connections between them are weak. However, service phenomena often include social and human resources, resulting in parts that are more tightly coupled with emergent properties. When connections are strong, the science for analysis must necessarily be that of a systems science, rather than reductionistic science, and systems thinking must be employed. This implies that not only are parts to be understood on their own, but that their role as part-wholes in the whole system must be considered simultaneously. Our paper, with a particular focus on service systems and complex service systems suggest that when the term 'system' is used, the research must make explicit how system principles are reconciled with the proposed methodological approaches. Our paper contributes to service research by proposing how the reconciliation could be achieved. Through 11 propositions, we have shown how systems thinking can be employed to understand complexity, and the adoption of *vSa* can be a meta-model supporting the understanding of complex service system design and management. We also illustrate how the integration of an engineering approach can also lead to the understanding of service systems while upholding holistic systems principles with *vSa* as a meta-model to facilitate a richer comprehension of behaviors in uncertain conditions. Future research should address complex service phenomenon through systems theory so as to better understand reality.

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