Chapter 2
Smart Public Services: Using Smart City and Service Ontologies in Integrative Service Design

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2.1 Introduction

In order to understand the premises of service development, we need to identify their primary functions and logic, plus the societal context within which such services are provided. This view is particularly relevant when dealing with public services, which are collective in varying degrees both in the supply and demand side of service delivery. Such a contextual view urges us to ask how the increase in complexity and the acceleration in the pace of change in the economy, governance, and social life affect the development of public services. One of the most critical factors to be taken into account is technology. This chapter focuses on this particular issue—i.e., how smart technologies are transforming public services.

The nature of services is rather superficially analyzed in public administration and management, which can be explained not only by the long-lasting emphasis on bureaucratic principles, but also by New Public Management (NPM), which provided an equally narrow view of public services (Brown, Ryan, & Parker, 2000; Hood, 1991; Osborne & Gaebler, 1992; Peters, 2011; Walsh, 1995). There are more contextual approaches to public services, such as New Public Service (Denhardt & Denhardt, 2003). However, they have not dug deeply enough into the nature of services as such; they have rather concentrated on the special conditions of public services, such as political leadership, the democratic setting, or citizens' rights. We may thus conclude that in the field of public services, we need to learn from those disciplines that have generated nuanced analyses of the nature of services—the

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M. P. Rodriguez Bolivar (ed.), *Setting Foundations for the Creation of Public Value in Smart Cities*, Public Administration and Information Technology 35,
https://doi.org/10.1007/978-3-319-98953-2_2

most promising of them being an interdisciplinary research field known as service science (Maglio, Kieliszewski, & Spohrer, 2010; Qiu, 2014)—and to utilize such approaches in refining the analysis of public services.

2.1.1 Service-Dominant Logic and Service Transformation

The emergence of service science is the result of an academic interest in services, which have long been an underdeveloped area in the social sciences. One of the most promising attempts to reconceptualize services is based on the idea of service-dominant (S-D) logic. It assumes that the key inter-organizational and societal processes are actually concerned with the exchange of services, going so far as to claim that all economies are essentially service-based. One of the tenets of S-D logic is that service marketing should break free from the traditional industrial or manufacturing-based model—i.e., goods-dominant (G-D) logic. S-D logic embraces the concepts of value-in-use and the co-creation of value rather than value-in-exchange associated with traditional G-D logic and related market transactions. Thus, S-D logic takes a broad view of the value created by organizations, including a view that emphasizes the need to work and market *with* customers and other value-creation partners in the wider value network (Vargo & Lusch, 2008; Vargo, Maglio, & Akaka, 2008; see also Shaw, Bailey, & Williams, 2011). However, it is necessary to note that even if S-D logic provides a more nuanced ontology than earlier theories, it is still largely in a pre-theoretical state (Mikusz, 2015).

Even though S-D logic came about with private-sector practices and market transactions in mind, it has a potentially equally important role in reconceptualizing public services, since the effectiveness of a wide range of public policies and the services that are designed to realize such policies depend on the value networks associated with each service. Yet, at the same time, the early theorization of S-D logic requires conceptual extension in order to construe the special nature of the public domain, including the factual role of co-producers in public service (see, e.g., Bovaird & Löffler, 2012; Fledderus, Brandsen, & Honingh, 2015); the importance of the collective aspect in the processes associated with the creation of public value (Moore, 2002; Osborne, Radnor, & Strokosch, 2016); and the dilemma of the role of legal compulsion in this picture (Alford, 2015).

Public services and related value creation cannot be sufficiently conceptualized without taking into account their context. This points to critical factors in the political, economic, social, and technological environments, which both enable and constrain public value-creation processes. For example, digitalization, servitization, networking, mediatization, the increase in self-service, and similar trends in service systems development have brought about a radical service transformation that affects practically all instances of the production, delivery, and consumption of public services (see, e.g., Zysman, Feldman, Murray, Nielsen, & Kushida, 2011). There is an obvious need for a theorization of public services and service management that takes into account the requirements of the era of network-based new public governance and its complex, ever more intelligent environment (Osborne, Radnor, & Nasi, 2012). As part of this endeavor, we need new ways of conceptualizing "public value," as it should reflect the constantly changing challenges and conditions of the interdependent and interconnected world (Osborne et al., 2016). In other words, values are not created atomically in a dyadic relationship between the service provider and customer; they are co-created jointly within the context of a wider service system made up of intermediaries and other stakeholders supported by various kinds of platforms and cyber-physical systems. These conceptions show the division of labor and the patterns of interaction between the public and private sectors in a new light (Paton & McLaughlin, 2008, p. 79; Vargo et al., 2008; Gallaher, Link, & Petrusa, 2006, pp. 7–11, 117).

A critical element in such a picture is the impact of new information and communication technologies (ICTs) on public services in the urban context, which originated in the application of IT in public administration—a trend that has broadened and become more sophisticated under the e-government umbrella since the late 1990s—and seems to have been at least partly reframed by smart city discourse, which directs attention to the urban context and the enablement of intelligent cyber-physical systems (Anttiroiko, Valkama, & Bailey, 2014; Komninos, 2015). Such a development is primarily a result of technological advancements, including GeoWeb, location-based services (LBS), ubiquitous technologies (esp. UbiWeb, sensors, and RFID), the Internet of things (IoT), Web^2 (Web 2.0 + AI), and Augmented Reality (AR) (Anttiroiko & Caves, 2016; Komninos, 2015), which integrate bits and atoms—that is, they reinforce relations between the physical and virtual worlds (e.g., Mitchell, 1996).

The essence of smart city services revolves around technologically enhanced systemic and collective intelligence that drives innovation through user engagement, big and real-time datasets, and ICT-enabled behavior. Since the late 1990s, the key issue has been digitalization, and more recently datafication and cloudification, yet this continuously diversifying discourse has taken up numerous relevant dimensions of smartness in urban life, thus distancing itself from the one-dimensional techno-centric view that dominated the approach to the smart city in the early stage of its development. The smartness associated with smart city discourse is thus multi-dimensional (on typologies of smartness or intelligence, see, e.g., Chourabi et al., 2012; Nam & Pardo, 2011; Piro, Cianci, Grieco, Boggia, & Camarda, 2014). In this chapter, the discussion revolves around productive smartness—which affects directly value-creation in public services—being connected to other aspects of smartness, from the technological to the social (Anttiroiko, 2016). This view boils down to a need to increase our understanding of how smart environments help to make public services smarter, and how such smart public services depend on the societal context in their complex value co-creation processes.

2.1.2 In Search of the Logic of Public Smart Service Deployment

The above-mentioned discussion highlights the need to understand the preconditions for urban innovations in public services in context, which will be addressed in this chapter by shedding light on the intersection of service-dominant logic and smart urban environments. The thematic core of this discussion lies in the digital dimension of public service innovation (Peters et al., 2016), its major contribution being to reveal the critical or strategic points that should be taken into account in the development of smart public services.

This chapter aims at pinpointing the critical aspects of the S-D approach in the public sector context and smart city development, and on that basis providing a coherent analytical picture of how instances of smart city development can potentially enhance the ability of public service organizations to create value within service-dominant logic.

This research problem entails the conceptual clarification of the S-D approach and the smart city paradigm, and the theoretical elaboration of their intersecting areas. Our focus is on the latter aspect, as it has not been properly conceptualized in the current discussion on public services.

2.1.3 Methodology

Methodologically, the nature of the challenge of analyzing public services through S-D logic and in connection with the applications, tools, and systems of smart cities is, first and foremost, conceptual. This requires conceptual and theoretical analyses that clarify the core components of both S-D logic and the smart city model, and also the public service as an instance of the public domain. Our primary tool in this endeavor is an ontological analysis as applied in information sciences. It operates at the conceptual or semantic level, referring in practice to semantic modeling (Wand, Storey, & Weber, 1999). It is worth stressing, however, that our conceptual models are more about phenomena than data, for we are interested in the general features of our target system rather than in building a semantic field (see Frigg & Hartmann, 2017). We conduct an applied ontological analysis of how the three domains that intersect in the concept of smart public services—(a) the smart city as an intervening domain, (b) S-D logic in services as the generic core domain, and (c) the public sphere as a special application domain—can be broken down into general categories and how their interrelations allow us to sketch critical points that are relevant in assessing the potential of smart city developments to enhance value co-creation in public services.

Concerning the conceptualization of services, our analysis draws on key contributions in the discourse on S-D logic (e.g., Vargo et al., 2008; Vargo & Lusch, 2008). Special attention is paid to the foundational premises of S-D logic and value co-creation among service systems, as theorized by Vargo et al. (2008). We utilize an ontological analysis in pointing out the key concepts relating to S-D logic (Fragidis & Tarabanis, 2011).

Our discussion about the smart city is built on a smart city ontology (Komninos, Bratsas, Kakderi, & Tsarchopoulos, 2015) or, more broadly, the ontology of smartness in the context of urban development, which has a decisive impact on how smart city tools and applications are applied and, thus, how they contribute to broadly defined productive smartness (Anttiroiko et al., 2014).

In our analysis of the public sphere, we take into account hierarchies in public service provision, the political and institutional context, and the conceptualization of public services in terms of public value (Moore, 2002) and the degrees and forms of publicness (Haque, 2001; Pesch, 2008). Therefore, we will point out the key features to be taken into account when analyzing the intersection of technological advancements and the contextual understanding of services in the given application domain. For analytical purposes, we rely on a dichotomous view of public administration, thus having two ideal types as our point of departure: administrative machinery serving passive service beneficiaries vs. enabling authority empowering citizens. This helps to conceptualize the public domain in a way that is sensitive to the theorization of smart cities and smart services. The respective dichotomy in the smart city applications is between the application of artificial intelligence in community informatics and the use of the "wisdom of the crowd" or crowdsourcing, which requires active human input in the community or service development process.

By combining these three elements, we will be able to develop a conceptual scheme of S-D logic in a smart city context with a special view of how the latter enhances the value creation within S-D logic and the value co-creation in the service systems in particular.

In the empirical section, the core aspects of value creation in services will be exemplified by references to two real-life smart city applications. Even though we discuss smart city services, which are conceptually close to e-services, the vast literature on public services in e-government discourse does not provide an exhaustive discussion of this topic (see, e.g., Al Ajeeli & Al-Bastaki, 2011; Weerakkody & Reddick, 2012). Most importantly, our attention is directed to urban services relating to infrastructure, mobility, and community life, which sets the basic criteria for the case selection. This has an inherent connection to another requirement; the cases must be nuanced enough to point to the intersecting areas of service and smart city ontologies. An additional requirement relates to the nature of the public domain, for we wish to present descriptive cases that reflect the previously mentioned dichotomy of managerially oriented public services vs. co-produced services that involve direct citizen involvement. Among the large pool of cases available in smart city literature and open smart city repositories, such as ICOS (http://icos.urenio.org/), we chose Smart+Connected Traffic and Improve My City, as they match well our selection criteria. It is worthy of note that as the main contribution of this chapter is theoretical, these case descriptions or vignettes serve the purpose of exemplifying the conceptual intersections of service science and smart city discourse in the public domain.

2.2 Fundamentals of Service-Dominant Logic

The idea of service-dominant (S-D) logic has its roots in an attempt to reconceptualize the nature of the modern economy by showing the deficiency of anchoring the view of value creation in production on manufacturing. It is associated primarily with the works of Vargo and Lusch (2006, 2008, 2016) and their colleagues in marketing. Their way of reconceptualizing services and the entire modern service economy has become exceptionally popular in the academic community, evidently becoming a cornerstone of service science (Chesbrough, 2005; Spohrer & Maglio, 2008).

As mentioned above, discussion about services is too often based on goods-dominant (G-D) logic, which relies on the concept of value manifest in the exchange of goods into money in competitive markets, with distinct spheres of production and consumption. However, this is an insufficient basis for understanding services and their role in contemporary society. The value of services is created when they are used, hence the idea of value-in-use (see Table 2.1). Moreover, this value is co-created jointly in interaction among providers and beneficiaries through the integration of resources and the application of competencies. Such value creation is embedded in society, implying that dyadic value co-creation by the producer and consumer is integrated in the broader societal context through complex resource integration. Thus, as all economic and social actors are resource integrators, and as all the structures, systems, and spaces of society can potentially add value in the process, the previously mentioned value-in-use concept must be extended to value-in-context to better reflect the true nature of services (Vargo et al., 2008).

Vargo and Lusch (2008) have modified the premises of S-D logic slightly over the past 10 years (see Allen, 2015). There are currently eleven premises of S-D logic, of which five are fundamental and called axioms (Vargo & Lusch, 2016), as presented in Table 2.2.

Vargo et al. (2008) have taken a kind of systems theoretical view of services. This reveals an important aspect of the anticipated paradigm shift, for attention is directed at processes that integrate resources rather than at the units of firms' outputs. This integration does not happen randomly or on an *ad hoc* basis, but largely in an environment that includes established conditions with multiple resource integrators who

Table 2.1 Goods-dominant vs. service-dominant logic: key concepts (adopted from Vargo & Lusch, 2006)

Goods-dominant logic concepts	Transitional concepts	Service-dominant logic concepts
Goods	Services	Service
Products	Offerings	Experiences
Feature/attribute	Benefit	Solution
Value-added	Co-production	Co-creation of value
Supply chain	Value chain	Value network
To market	Market to	Market with
Product orientation	Market orientation	Service orientation

Table 2.2 Axioms and foundational premises of service-dominant logic (Vargo & Lusch, 2016)

A1 (FP1) Service is the fundamental basis of exchange
FP2 Indirect exchange masks the fundamental basis of exchange
FP3 Goods are distribution mechanisms for service provision
FP4 Operant resources are the fundamental source of strategic benefit
FP5 All economies are service economies
A2 (FP6) Value is co-created by multiple actors, always including the beneficiary
PF7 Actors cannot deliver value but can participate in the creation and offering of value propositions
PF8 A service-centered view of inherently beneficiary oriented and relational
A3 (PF9) All economic and social actors are resource integrators
A4 (PF10) Value is always uniquely and phenomenologically determined by the beneficiary
A5 (FP11) Value co-creation is coordinated through actor-generated institutions and institutional arrangements

A Axiom (in bold), FP Foundational premise

operate under specific societal rules and sector-specific conventions. Vargo et al. (2008) have introduced the concept of "service system" as an abstraction of the structural features of the value creation process. They assume "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" (Vargo et al., 2008, p. 149). In the name of conceptual clarity, it should be noted that such a system always comprises core dyadic elements as a necessary condition—i.e., the service provider and service client who work together to co-create value in complex value chains, constellations, or networks (Spohrer, Maglio, Bailey, & Gruhl, 2007). Such systems are always *de facto* "configurations of people, technologies, organizations, and information that create and deliver value to all stakeholders in the system" (Vargo & Lusch, 2008; see also Peters et al., 2016). How to define the boundaries of each system is a dilemma of its own, and it will not be discussed here (see, e.g., Barile, Saviano, Polese, & Di Nauta, 2012).

Vargo et al. (2008) define value in terms of an improvement in system well-being, which is a conceptually vague point if the system can be of any configuration. However, the vagueness is decreased if we are able to define the boundaries of each system, the key aspects of its composition, and the criteria that specify the "ownership" or the performance perspective from which such well-being is defined. In any case, such an S-D logic approach brings a theoretically important contribution to the understanding of the role of service systems, the co-creation relationship between providers and clients or users, the transformation of inputs and the control of "to-be-transformed" part of the world in the case of co-creation taking place in a context that is partly outside the control of either party of the dyadic core relationship.

The co-creation relationship is a key relation in S-D logic. In such a relation, the client owns or controls some aspects of the social setting that the provider aims to transform guided by its value proposition, which is formalized in some kind of agreement between the provider and client. For example, a university as a service provider aims to transform student knowledge through educational activities and related support functions, which are in various ways embedded in and conditioned by the surrounding society (Peters et al., 2016; Spohrer et al., 2007). The individual's role in such processes has been evolving for some time from a passive service beneficiary to that of an active, informed partner or co-creator in service provision, problem-solving, development, and innovation, contributing to co-design, co-production, or co-delivery, depending on the actor's role in each case (Kannan & Chang, 2013; Nambisan & Nambisan, 2013; Tuurnas, Stenvall, Rannisto, Harisalo, & Hakari, 2015). Such a theorization opens up a view of the necessity for service systems to support accessibility, empower users, facilitate value creation processes, and increase system-level adaptability, which are decisive in the creation of well-being within service systems as instances of the economy.

"Service system" is an abstraction, referring to an arrangement of resources—people, technologies, rules, information, etc.—connected to other systems by value propositions. Accordingly, systems relate to each other, including the utilization of one another's resources in varying forms and scales. Such systems co-create value and thus include fundamental meta-level systemic interdependencies (Maglio, Vargo, Caswell, & Spohrer, 2009; Vargo et al., 2008). Such an interdependency actually creates a field of overlapping composite service systems, which is dynamic in the sense that they are composed, recomposed, and decomposed when some essential aspects of the systemic whole change (Maglio et al., 2009; Mikusz, 2015). Such a composition can be based on various forms of governance, of which the three basic modes are hierarchy, market mechanism, and networks (Lazer, Mergel, Ziniel, & Neblo, 2009; Niehaves & Plattfaut, 2011; Thompson, Frances, Levacic, & Mitchell, 1998).

Spohrer et al. (2007, p. 72) define the service system as

> a value-coproduction configuration of people, technology, other internal and external service systems, and shared information (such as language, processes, metrics, prices, policies, and laws). This recursive service system definition highlights the fact that service systems have internal structure (intraentity services) and external structure (interentity services) in which participants coproduce value directly or indirectly with other service systems.

In service science, this idea has been taken further by framing the analysis of services with the "service ecosystem," which emphasizes the role of intersections, dependencies, and connectedness in the value creation of services (Wieland, Polese, Vargo, & Lusch, 2012). The generic process and key components and relationships of S-D logic are illustrated in Fig. 2.1.

2.3 Service-Dominant Logic in the Public Domain

Service-dominant logic attracted attention in public administration soon after its appearance in marketing. Osborne et al. (2012) were among the first to highlight the implications of S-D logic for public service management. According to them, the rise of such logic is due to the increasingly fragmented context of public service

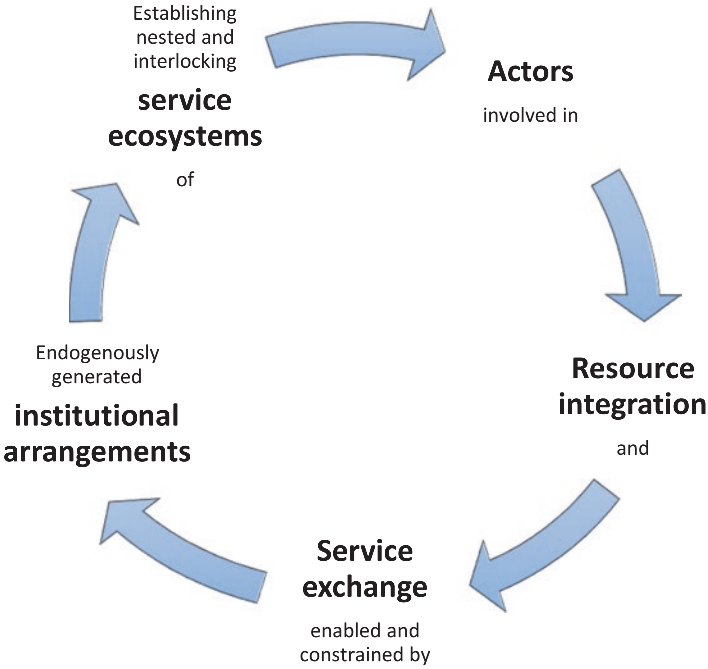

Fig. 2.1 Outline of the process of service-dominant logic (Vargo & Lusch, 2016)

delivery, which implies that the management of public services must take into account a wider set of interorganizational and cross-sectoral players as well as a systemic view of public service that is able to overcome the limits of the perspective of an individual organization. Another reason for the need for a paradigm shift in public service management is the reliance of contemporary management theory on generic theories derived ultimately from G-D logic, which have led to an unsatisfactory situation in the theory and practice of public services.

Osborne et al. (2012, pp. 141–148) hold that the theory of public service management would be enhanced by the adoption of a public service-dominant logic (PSDL) approach. They have developed four propositions concerning this approach in the public sector context.

- The first proposition regards strategic orientation: they state that in adopting a public service-dominant approach to public services delivery, both citizens and users are situated as essential stakeholders of public policy and public service delivery processes.
- The second proposition concerns the marketing of public services, which is essential for turning the strategic intent of a public service into a specific service offering, shaping the expectations of this service by its users and the role of staff in delivering it, and developing trust within public service delivery between both public service organizations (PSOs) and service users.

- The third aspect of this approach highlights the importance of the idea of co-production. Osborne and colleagues state that “coproduction becomes an inalienable component of public services delivery that places the experiences and knowledge of the service user at the heart of effective public service design and delivery” (see also Osborne et al., 2016).
- Lastly, they claim that the operational improvement methodologies implemented within public organizations have had an intraorganizational (product-dominant) rather than extraorganizational (service-dominant) orientation, leading to the fourth proposition: without an S-D approach, operations management will only lead to more efficient but not more effective public services, while without operations management, an S-D approach to public services will lead simply to an unfulfilled public service promise.

Among the challenges in the adoption of S-D logic in the public sector, Osborne et al. (2012) refer explicitly to information and communication technologies (ICTs). While some judge the results of the application of ICTs negatively—opinions varying from the application being chaotic to it being a missed opportunity—ICTs have undeniable potential, and some of this potential works at the very core area of S-D logic, most notably user and citizen engagement with public service delivery. Osborne and others end up arguing that digital governance may well develop hand in hand with a PSDL approach (cf. Dunleavy, Margetts, Bastow, & Tinkler, 2006).

Nevertheless, both conventional service theory and S-D logic have their limitations in explaining and understanding the premises of public service management. The latter requires an understanding of the political and policy contexts of public services, and the occasional need to deal with unwilling or coerced service users or subjects, as in the case of the criminal justice system (Alford, 2015; Osborne et al., 2016). A key element in this issue is the concept of public value, for it is a matter that characterizes value creation in the public domain (Moore, 2002). Even if S-D logic makes the view of value creation more sophisticated, it seems to presuppose that value is always determined by the beneficiary, which does not provide a sufficient conceptual tool to understand such concepts as “public goods” (Batina & Ihori, 2005; Holcombe, 2000) or “public value” (Moore, 2002). In short, the idea of public value requires a broader view of value creation than that of the dyadic or beneficiary-centered view of service systems. This relates to the question of whether value can be co-created in the first place, as contended by Hilton, Hughes, and Chalcraft (2012), who view value as a personal evaluative judgment and thus impossible to be genuinely co-created. This view, however, does not take into account public value, which is collective in nature and cannot be assessed by individual evaluative judgments alone.

Another aspect of the S-D approach worthy of critical assessment in the case of public services is the concept of “service system,” which was analyzed by Vargo et al. (2008) in the context of the market, thus inherently limiting its applicability to public and voluntary sectors. In a market-centered view, service providers propose value in the market based on their capabilities, which is then accepted, rejected, or left unnoticed by other service systems in need of resources. That is, each service system accesses operant resources (services) from other systems through market exchange—hence the idea of seeing any actor capable of social interaction as a "service system." In public services, the concept of a system is seen differently, due to its inherent supply-side orientation and its connection to public policy and its institutional boundaries. While a firm can freely look for operant resources to fit in with its value proposition in the market, public service organizations do not always have such latitude. This means that S-D logic, even if it helps us to reconceptualize the creation of value in public services, is in reality more constrained in the public domain than in private organizations or the market. This is manifested in legal frameworks and service regulations, strict rules for outsourcing public services, and the legally specified citizen-customers' rights concerning access to and usage of public services. The latter point further highlights the need to see the qualified meaning of value co-creation in the public sector conditioned by political will, bureaucratic conventions, and legal provisions.

Lastly, an important point to be made here is that as clear as the concept of public service may sound, its publicness is nuanced and multi-dimensional—i.e., the degree of publicness concerning such criteria as public value, democratic control, public finance, and managerial practices vary case by case. For the same reason, the seemingly clear demarcation between the public sector and other sectors of society is somewhat elusive (see Coursey & Bozeman, 1990; Haque, 2001; Stirton & Lodge, 2004; Rutgers, 2003; Stout, 2012). In fact, it has become challenging and perhaps even irrelevant to classify organizations as purely public or private using some formal criteria. The boundaries between the two sectors are blurred, making it plausible to apply a dimensional approach that assumes their difference is largely a matter of degree (Antonsen & Beck Jørgensen, 1997; Scott & Falcone, 1998). Nevertheless, we may assume that for a service to be called "public," it must fulfill at least the following minimum definitional criteria: a service is essentially public if the decision of its launch, design, and provision is collective and at least indirectly democratic, and a considerable share of its costs are collectively (publicly) funded.

2.4 The Smart City as an Enabler in Service Transformation

Even if the idea of the smart city is rooted in technological advancements as the principal enabling factor, recent literature repeatedly emphasizes the need to put smartness into a broader context. In short, new technologies do not form a sufficient condition for the creation of a smart city. Battarra, Gargiulo, Pappalardo, Boiano, and Oliva (2016), for example, emphasize that a smart city is made of smart people who are supposed to create and benefit from the smart city development model through synergies made possible by governance structures and smart institutions (see also Huston, Rahimzad, & Parsa, 2015). This implies the need for an integrated approach that takes citizen engagement into account, viewing citizens as informed, networked, and empowered co-creators of the smart city. The same holds with the co-creation of smart local public services. It is nevertheless important to keep in mind that the smart city brings into the picture the multi-dimensional urban development model, where technological advancements and artificial intelligence are used to enhance collective intelligence within local and broader societal contexts with the aim of improving competitiveness, effectiveness, quality of life, and sustainability in the urban community (Anttiroiko, 2016; cf. Battarra et al., 2016; Papa, Gargiulo, & Gladeris, 2013). As a development-oriented concept, it has an inherent connection with the functioning and development of public services, even though its scope goes far beyond the domain of narrowly defined public services.

The smart or intelligent city marks a turning point in the evolution of urban development paradigms. It is in essence about the power of new technologies, most notably the Internet, in empowering citizens and organizations to create urban innovations and collaborative solutions that make cities more efficient, inclusive, and sustainable. Technology-wise, such a city is built upon broadband networks, software applications, data from sensors, and IT-facilitated user engagement, which make it dynamic, designable, and responsive. The ontology behind conceptualizations of the smart city reveals the three building blocks of its essence: (a) the city as an activity setting, as expressed by such concepts as city, citizen, user, activities, infrastructure, and flows in cities; (b) the city as a knowledge setting, referring to information, knowledge, intelligence, and innovation processes and institutions within cities; and (c) the city as a technological setting comprising smart systems, urban technologies, the Internet, broadband networks, and electronic services (Komninos, 2015; Komninos et al., 2015).

The smart city is not a particularly clear development concept, nor have its real-life manifestations proved to be particularly successful—so far at least. Actually, there is an underlying problem regarding the low impact of smart city applications observed in such fields as energy and transport, which constitute high-priority areas for smart urban development. Even if our focus is on public services in a more generic sense, including welfare services, discussion about smart city developments is important due to the increased integration of the physical and virtual. Komninos et al. (2015) have addressed this issue by analyzing the reasons for the low impact of individual smart city applications. Their main argument is that the impact of applications depends primarily on their ontology and only secondarily on smart technology. Our interest is in this particular observation, as it may be a key to understanding the embeddedness of public services in evolving smart environments.

2.4.1 Smart City Ontology

Let us start with a conceptual clarification. In computer science, ontology describes conceptual classes, attributes, and relationships depicting a given aspect of worldly reality—in this case, constitutive aspects of the smart city—and it contributes to the building of key concepts in the given domain and the semantic web to be utilized in information exchange between computers and humans in a complex environment. The initial step is to define a smart city ontology (SCO) that is based on the three general aspects of the smart city mentioned earlier: activity, knowledge, and technology settings. The idea is reminiscent of intuitively and theoretically created smart city typologies, such as Nam and Pardo's (2011) technology, people, and institutions, or the six-dimensional model sometimes referred to as the Smart City Wheel, which describes smartness relating to people, the environment, the economy, governance, mobility, and living (Angelidou, 2015; Anthopoulos & Vakali, 2012; Cohen, 2012; Murgante & Borruso, 2013; Piro et al., 2014). As mentioned above, a more elaborated conceptual scheme has been developed by Komninos et al. (2015) based on the cloud of terms included in the most frequently cited smart and intelligent city definitions, which results in the superclasses described in Fig. 2.2. Komninos et al. (2015) have defined the building blocks of SCO by combining elements of the city structure and the definition of the smart city. This ontological design contains 708 entities, 422 classes, 62 object properties, 190 data properties, and 27 individuals from the software applications class. We rely on this schema in our conceptualization of the smart city.

Our next step is to take a brief look at service ontology, and then to identify the intersections between the main categories (superclasses) of these two domains.

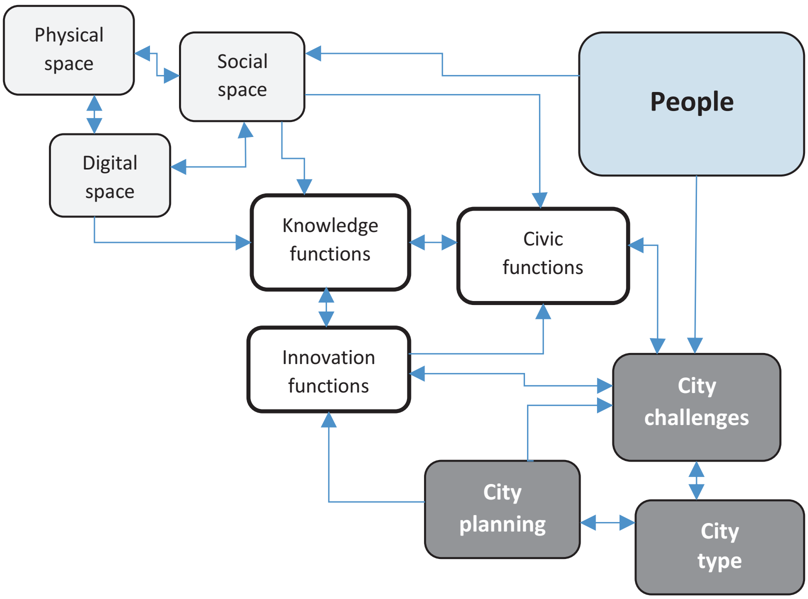

Fig. 2.2 The superclasses of smart city ontology (Komninos et al., 2015)

2.4.2 Service Ontology

Concerning services, our primary reference is the conceptual structure built as a kind of domain ontology from the previously discussed premises and process of S-D logic that was inspired by the criticism of the old service paradigm associated with goods-dominant logic (Vargo & Lusch, 2008, 2016). Since the 2000s, there has been an increasing number of attempts to make the ontological and conceptual foundations of service science more sophisticated (Alter, 2008; Basole & Rouse, 2008; Ferrario & Guarino, 2009; Weigand, Johannesson, Andersson, & Bergholtz, 2009). It is noteworthy that traditionally the main categories of service ontologies were derived chiefly from the narrowly defined relation between service provider and service consumer, which provided too limited a view of value creation in services. On the other hand, S-D logic as a framework still suffers from conceptual vagueness and even inconsistencies, and thus it has yet to mature in order to become a foundational theory of service science (Ferrario & Guarino, 2009; Fragidis & Tarabanis, 2011).

According to Spohrer and Maglio (2010), the ontological foundation of S-D logic—and actually of service science in general—is value creation in service systems. This highlights two fundamental categories of service science: service systems, which refer to the basic entities in service-based environments, and value co-creation, which points to the basic activity that emanates from interactions between service system entities. Fragidis and Tarabanis (2011) have elaborated on this discussion by developing an ontological foundation of S-D logic that not only identifies and explains the key concepts, but also analyzes their relationships, thus providing means for the clarification of this conceptual field and a deeper understanding of S-D logic. Their preference for an "ontological foundation" over "ontology" is telling, as it implies that they operate at the preliminary stage of ontological analysis, which lacks the rigor of formal ontologies. Their scheme is based on concepts derived from the ten foundational premises of S-D logic and the discussion on the need for a lexicon of S-D logic (Vargo & Lusch, 2008).

Fragidis and Tarabanis (2011) include the following concepts in their ontological model of S-D logic: Actor (Customer and Provider), Service, Value, Value Co-creation, Resource, and Context. This categorization of the key concepts is only indicative. (cf. Loutas, Peristeras, & Tarabanis, 2011; see also Vassilakis & Lepouras, 2006; Zefferer, 2016). Their model is illustrated in Fig. 2.3 in the form of a class diagram.

2.4.3 Overlapping Areas of Smart City and Service Ontologies

The most obvious intersection of smart city and S-D logic ontologies is (a) e-services or smart city services, which points primarily to digital space that offers platforms, smart systems, and technological tools in the value co-creation process in services.

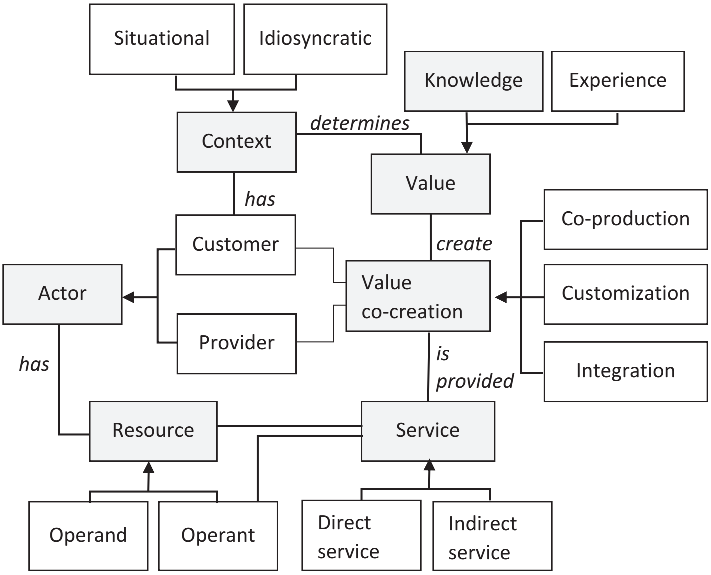

Fig. 2.3 An ontological model of S-D logic (modified from Fragidis & Tarabanis, 2011)

In the formal smart city ontology, e-services have a connection with urban challenges, including such heterogeneous aspects of urban life as production, infrastructure, quality of life, and governance (Komninos et al., 2015). Another intersecting area relates to (b) knowledge function, which serves as an underlying element of service informatics and related information and learning processes, and through them affects value co-creation processes and outcomes. As S-D logic emphasizes the role of the client and the relevance of the beneficiaries' view of the value of service, the (c) class of people forms the third joint aspect of these two domains. Lastly, the broadly defined (d) urban ecosystem forms an intersecting area depicting the city as an urban settlement with actors and their relationships, pointing to the context for service networks or a broader service ecosystem that shapes value co-creation processes. These four critical intersecting areas are illustrated in Fig. 2.4.

2.4.4 *Cyber-Physical Systems As Resource Integrators*

Digital space is one of the super-classes of SCO for a good reason. Generally speaking, such spaces are enablers of higher-level coordination, governance, problem-solving, and innovative behavior. They are made of a kind of system of digital rings or layers superimposed and bonded together, each having special characteristics and functionalities. The core hardware ring of this scheme includes broadband networks, sensor networks, and various types of access devices surrounded by the ring of data and web technologies, and further by an application ring composed of a

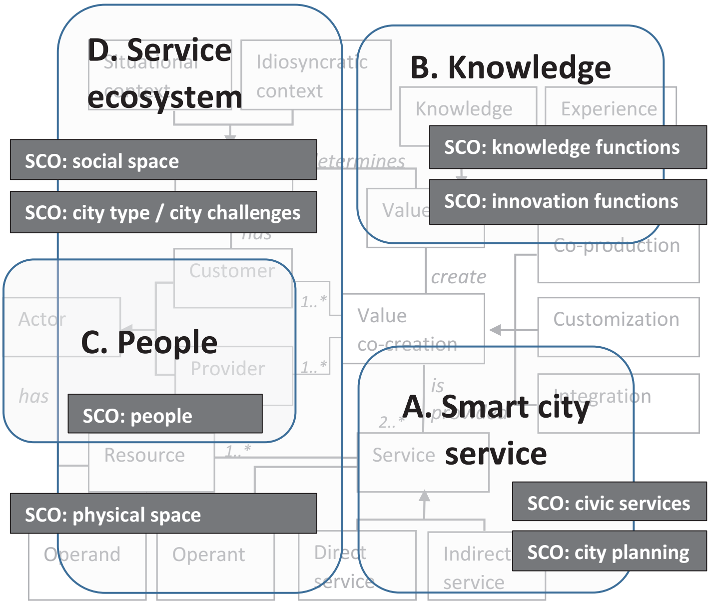

Fig. 2.4 Overlapping areas of the smart city and service ontologies

range of software applications belonging to the city's various domains, covering such main subsystems as the economy, quality of life, infrastructure, and governance (Komninos, 2015). From the point of view of S-D logic, the outer ring, which includes such essential aspects of the public domain as public governance, policy design, urban planning, decision making, and public services, is arguably the most important one; it includes electronic services provided collectively under democratic control and organized by the city government.

The horizon opened up by the smart city ontology is more than just a conventional view of electronic services. It is essentially about how human, collective, and artificial intelligence facilitated by digital environments address the challenges of our physical and social worlds. For any defined service system or other social domain there is a respective functional whole, the cyber-physical system (CPS), which comprises interconnected, distributed embedded systems—buildings, cars, machines, etc.—that directly record physical data, combine these data with other available data and services, and on that basis interact with physical and digital worlds (Mikusz, 2015). On some occasions, they are called cyber-physical systems and services (CPSS; Peters et al., 2016). CPS represents a complex service system design, which when fully developed serves as a dynamic, semi-autonomous resource integrator that through information-intensive activities co-creates location-based and context-aware value propositions, reflecting S-D logic's idea of value-in-context (Glushko, 2010; Mikusz, 2015). Theoretically, we may approach each system as an atomic entity, even though due to the integrative functions and diffuse nature, the demarcation of these systems from their environments can have only a heuristic function. Rather, CPS functions as if it were essentially a system of systems (SoS).

Discussion about CPS is a way of crystallizing the contribution of smart city development to service architecture relying on S-D logic, for many of the interactive service processes are facilitated by ICTs and, more generally, most of the physical systems are actually becoming cyber-physical (Komninos, 2016), which reflects a general tendency of the information age to replace interaction with information (Glushko, 2010). CPSs are embedded physical and engineered systems whose operations are monitored, coordinated, controlled, and integrated by a computing and communication core. Therefore, they are essentially hybrid systems that integrate the digital and physical worlds (Komninos, 2016). In the field of public services, they form cyber-physical systems of public services (CPSPS), which integrate all essential elements of the service system embedded in the broader context, including various ontological layers needed to deliver services that bring about co-created value. This view puts public services into the context of smart environments (Komninos, 2015, 2016).

Mikusz (2015) has created a CPS framework that takes into account CPS's connection with S-D logic. In his model, CPS forms an evolving setting for the atomic service system, value creation networks, and broader service ecosystems mediated by the CPS platform with a managerial and technological layer, which all together create composite cyber-physical service systems (Mikusz, 2015). A key to the IT-based integration of the system is the CPS platform, comprising the hardware, software, and communication systems needed to ensure basic functionality for the operations of CPS at the technical system level. An even more important component of the platform is, however, its layer of operant resources—such as knowledge, interaction capabilities, organizational processes, relationships with co-creators, collaborative competences, etc.—which are key to the added value of the system. The service provider needs to transcend inter-organizational boundaries in order to exchange and involve the operant resources available in value networks, or, in other words, to develop capabilities that enable partners and customers to integrate their resources into the value co-creation process (Mikusz, 2015). The conceptual model of S-D logic-oriented CPS is illustrated in Fig. 2.5.

Mikusz's framework is based on a complex service system design, which as its paradigmatic outcome co-creates location-based and context-aware value propositions (Glushko, 2010). It coincides with S-D logic's understanding of value-in-context. Such a context is essentially bounded by two instances that reflect the dialectic of the digital and social: the variety and capabilities of the sensors by which context information can be acquired from the environment, and the willingness of people to allow service providers to use information about their location, identity, activity, and time that determine each service usage situation (Glushko, 2010; Mikusz, 2015).

The previously mentioned location-based and context-aware services reflect the most complex aspect of service system design. This design is a reflection of service transformation, which has evolved from an interactive dyadic relation to complex service systems. Besides complexity, it refers to the increased information intensity.

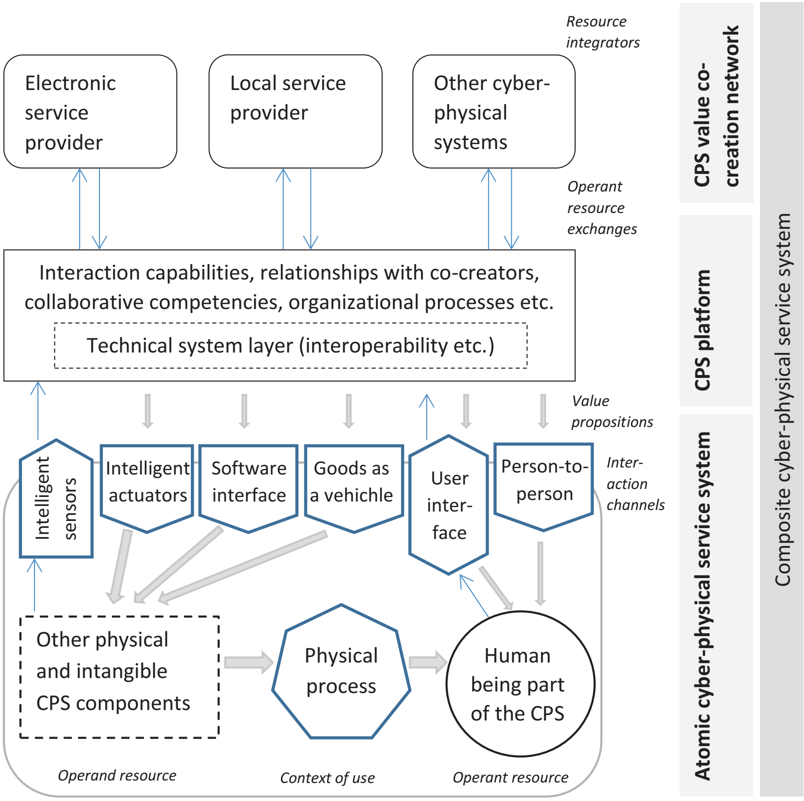

Fig. 2.5 Conceptual framework for CPS from the S-D logic perspective (applied from Mikusz, 2015)

Indeed, concerning its practical core function, CPS brings best value as a platform for information-intensive services that are connected to the physical world and personal interaction to varying degrees. By definition, information-intensive services comprise all such services in which the information actions are responsible for the greatest proportion of value created by the service system. Fully information-based services do not require any physical or interpersonal interaction as a core component of the service, but they can be readily automated as information systems, web services, or computational agents. Hybrid services involve essential personal or physical interactions—be it classroom teaching, surgical healthcare, logistics, or something similar—that can be assisted by IT-based information activities. Lastly, there are also services that are dominated by physical or interpersonal actions, from physical therapy to dining to a live show, making them experience-intensive, even though in their case information exchanges can be used also to specify and co-produce the service (Glushko, 2010; cf. Apte & Mason, 1995; Zysman et al., 2011). It is essential to remember that smart city development goes hand in hand with increased integration with physical, interpersonal, and information actions; this is visible in interconnections of spatial, social, and knowledge functions within SCOs.

2.5 Real-Life Cases: Smart City Services and Underlying S-D Logic

To illustrate the contribution of SCO and S-D logic to the functioning and development of public services, we will discuss two cases: Smart+Connected Traffic and Improve My City. These cases highlight the varying degrees of citizen involvement in providing public services. The cases are analyzed using the four categories—people, knowledge, services, and ecosystem—that connect digital smartness with service ontology (see Fig. 2.6). Lastly, we will discuss how these cases relate to citizen involvement and the creation of public value as the key elements of PSDL (see Osborne et al., 2012).

2.5.1 The Case of Smart+Connected Traffic

There are various kinds of control and monitoring services, such as traffic control systems, which improve urban functionalities without special input from citizens. They represent smart city applications *par excellence*. Their added value lies in increasing the capacity and intelligence of service informatics with the help of new ICTs. The majority of such smart solutions are developed by their private solution providers to be readily applied by their customers. A good example of how information and knowledge processes can be facilitated in the urban context is Smart+Connected Traffic developed by CISCO (see CISCO, n.d.).

The Smart+Connected Traffic solution addresses the two most important traffic challenges facing cities today: road safety and congestion. It helps traffic departments accurately detect incidents before they become more serious, and enables

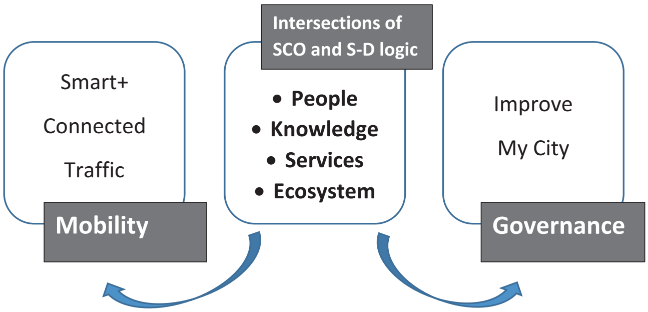

Fig. 2.6 The two cases discussed in this chapter

quicker responses by monitoring and analyzing traffic flow data. The solution stands out because of two important innovations: the fusing of data from multiple sources to identify incidents and reduce false alarms, and the integration of multiple applications into a comprehensive system (URENIO, 2012a).

Smart+Connected Traffic combines IP cameras, sensors, applications, and the Wi-Fi infrastructure to provide the monitoring of live traffic conditions for traffic management authorities in real time. The solution provides insight into urban traffic patterns to enable traffic authorities to make better decisions and long-term plans.

The basic features of Smart+Connected Traffic are organized into three categories as follows:

Traffic monitoring

- Displays live video from any traffic camera and presents live traffic conditions on a map
- Collects data on average vehicle speed, traffic volume, and lane occupancy
- Monitors social media for relevant information

Incident detection and management

- Identifies traffic incidents by fusing multiple inputs, displaying their locations on a map, and alerting operators
- Creates an incident record automatically and collects all relevant data into an incident management kit for operators
- Provides recommended procedures to guide operators quickly through the response process
- Helps ensure continuous communications with responders

Analytics, reporting, and administration

- Visualizes traffic incident trends to identify traffic flow issues
- Reports distribution of traffic incidents; reports and helps predict traffic flow patterns
- Configures and manages sensors, video infrastructure, and policy rules

All the four overlapping categories of "smart city" and "service" ontologies presented in Fig. 2.4 can be recognized in the structure and operation of this application. The people dimension of Smart+Connected Traffic actually reflects a conventional smart city initiative, which increases information intelligence in urban management, functionality, and maintenance, but does not require active citizen input as a precondition of its utilization. Thus, people are essentially beneficiaries of collectively organized urban management, and they affect the service indirectly within a representative system of government or occasionally by giving feedback as service users or exerting influence as active citizens.

The other intersecting category, knowledge, is associated with community-level artificial intelligence and the "algorithmic design" of the city. In essence, its artificial collective intelligence does not require critical input from citizens; it rather utilizes multiple data sources, which are processed by both computer systems and authorities or experts.

The factual service in this case revolves around traffic monitoring, incident detection, and reporting; it serves responsible authorities and departments in managing traffic-related issues. It is based on urban management and back-office functions rather than delivering interactive services to individual car drivers. This kind of smart service thus focuses on information processes rather than interactive functions (cf. Glushko, 2010).

Lastly, services have their contexts defined by their service ecosystems. The most immediate connection of the Smart+Connected Traffic system is with other monitoring and control systems that can add value to its information function. Even if not necessarily optimal, this feature in fact reflects one of the fundamental aspects of smart urban services: service integration and the use of sensing and communication infrastructure across smart service domains. It also provides information that can be utilized in city planning, zoning, and location decisions, thus connecting it with various urban management functions.

There is a plethora of applications that serve similar functions as Smart+Connected Traffic. Even if the above example concerns traffic, it can be applied to a wide range of public services, from park and sport facility maintenance to school safety. They share one characteristic feature: they utilize ICTs in monitoring and visualizing various aspects of community life, which helps responsible organizations to address quickly emerging problems and even to find patterns that enable a proactive approach to local problems.

2.5.2 User Involvement Through the Improve My City Application

One of the touchstones of the smart city endeavor is its ability to bring users to the center of public services. Even though smart city applications are in their infancy in this respect, they have started to indicate an ability to engage people in a smarter way than before. An example of an application designed to smarten up citizen and user involvement is “Improve My City,” which addresses direct government-citizen communication and collaboration in troubleshooting problems with the environment, infrastructure, and community life (http://www.improve-my-city.com/). The application was developed within the PEOPLE project in close collaboration with user groups and the Municipality of Thermi, Greece. The outcome is a user-centered digital application adapted to the needs of municipalities and local communities (URENIO, 2012b). This application received a special award from the Council of Europe for enabling local authorities to respond effectively to citizens’ requests.

The Improve My City application enables citizens to report any kind of local problem, such as illegal trash dumping, faulty street lights, broken paving slabs on sidewalks, potholes, illegal advertising boards, or any other issue that citizens might recognize as a problem to be resolved by the public authorities. Users may add photos, comments, and suggestions for improving their neighborhood's environment. The submitted issues are displayed on the city's real-time map.

Through this application, local authorities enable citizens and local actors to take action in improving their neighborhood. Reported cases are placed directly in the local authorities' work order queue. Users are informed of the time needed to deal with each case. When cases are resolved, the date and time of the resolution is made public by adding it to the list of solved cases, providing users with a realistic view of how diligently the local authorities are working on the improvement of the city.

The main characteristics of the application:

- Citizens are able to determine the exact location of the problem on the map and attach photos;
- The submitted cases are listed on the website and displayed on the city map;
- Each case is presented in detail showing: category, address, the name of the citizen who submitted it, the date of submission, a photo, description, user comments, location on the map, and the number of positive votes. Users can also comment, vote, and print out the cases;
- Citizens are informed about the status of their requests by e-mail. Initially, the status of each case is "Open." Once the municipality is aware of the case and has forwarded it to the relevant department, the status changes to "Acknowledged." Finally, once the case is resolved, the status becomes "Closed";
- Users can view only the cases that belong to specific categories or those that have a specific status. They can also sort the cases by date of submission, number of votes, and status;
- Citizens and employees of the municipality can make comments on existing cases. Commenting is allowed up to 10 days after the resolution of a case;
- Citizens can provide a positive vote on issues they consider significant. This process helps municipalities to assess and prioritize local problems;
- The submitted issues are managed through a web-based environment that utilizes the Joomla content management system. The management is distributed to the departments of the municipality;
- The authorized employees manage the entries through a web solution that presents all the available information. Analytics aggregate requests and give a comprehensive view of the citizens' requests and responses, as well as the effectiveness of the public authorities;
- The source code of the application is freely available as open source software released under GPLv3.

Concerning the smart city and service science intersections, people are genuine activators in this scene. They start the procedure for service delivery, offer input and content, and are the direct or indirect beneficiaries and assessors of services. They may contribute with ideas, prioritize requests, and influence the service queues at the public administration. As Foundational Premises 6 and 10 in Table 2.2 point out, value is co-created by multiple actors, and it is always uniquely and "phenomenologically" determined by the beneficiary. It is important to bear in mind, however, that the beneficiary may also be a collective, hence a legitimate view of "public value" also applies to cases that are based on the contributions of individual city dwellers.

Knowledge creation is a complex process, especially in cases that involve direct citizen input. We may divide such a process into three consecutive stages. The application enables information gathering from the citizen reporting a problem to the public administration; knowledge generation along the problem resolution by the public authority through internal network activation and the matching of requirements and competences; and information dissemination from the authority to citizens concerning the service processes and their outcomes. Such knowledge functions can be easily recognized in the Improve My City application.

Service creation is the culmination of the process. As illustrated in Fig. 2.1, it integrates actors, resources, institutions, and the ecosystem. The value co-creation that has manifested in the service is coordinated through institutions and institutional arrangements. The public authority offers the resources, empowers stakeholders, and, at times, re-organizes its internal hierarchy to meet the challenges posed by citizens.

Lastly, the ecosystem of the city is in a sense both a starting point for the service creation and its constantly evolving context. It defines the overall setting of the new service, such as the challenges and problems to address, key actors and beneficiaries, procedures of service activation, the value proposition of services offered, the business model, and sustainability. At some point, the ecosystem becomes hybrid as the digital application connects broadband networks, datasets, and electronic services offering a platform for online citizen engagement and seamless and integrated service delivery.

What is essential here in terms of community intelligence is the Improve My City application's ability to increase transparency, information, coordination, and participation in various issues that are relevant for the participatory governance of the city. This application belongs to a larger family of information platforms of "instant" crowdsourcing and participatory sensing, which through smart applications and a phone+camera+CPS combination are revolutionizing community informatics (Anttiroiko & Caves, 2016). Applications in this area eventually enable citizens to participate in improving the quality of their neighborhoods and community life. Such smart services have the potential to contribute to the citizen-centeredness of community governance and urban development.

2.6 Discussion

The previous discussion has identified the essential intersections of service and smart city ontologies—services, knowledge, people, and the urban ecosystem—which have been used as basic categories in the analysis of two empirical smart city applications. They show a fundamental difference between systemic/control-oriented and enabling/user-involving approaches to such applications, both having their own role in enhancing urban intelligence. The dilemma is obviously that despite the fairly clear picture of the added value brought about by smart city applications in the two ideal types of smart public services, real-life development is actually shadowed by a low-impact problem, as shown by Komninos and his team (2015, pp. 42–45). This raises the question of how the previously mentioned intersecting areas of service and smart city ontologies relate to the perceived low-impact problem. To shed light on this issue, let us start by listing the key findings derived from the previously mentioned analysis by Komninos' team.

1. Incrementalism: most smart city applications support an incremental product or process innovations for organizations—that is, only a few applications have the potential to bring about and sustain radical innovation at the sectoral or global levels.
2. Disconnectedness: continuity between digital space, knowledge processes, and innovation seems to break down. Applications rely on simple forms of digital space and become disconnected from their innovation potential and impact, which implies that attention should be paid at the design stage of each application to those categories of the ontology that would secure and increase the innovation potential of the application.
3. Critical role of knowledge processes: knowledge functions mediate digital spaces with the innovation potential or impact of applications, yet there is no significant relationship between the digital space and innovation variables. This highlights the central role of knowledge processes rather than digital space in making the city innovative. In addition, smart city applications generate knowledge that relates to information gathering and dissemination, while higher-level knowledge functions, such as skills improvement and the production of new knowledge, were not represented in the projects analyzed.
4. Limited transformational capacity: most smart city applications do not support a fundamental transformation related to the setting up of measurable systems, which implies a low level of internal information structuring and a low processing capacity to transform information and sustain informational intelligence. Smart city applications thus do not support in the best possible way the capacity of the applications to transform information inputs into knowledge outputs.

Smart city applications and services tend to introduce small-scale improvements rather than radical system-level changes. Novelties generated by applications relate first and foremost to knowledge processes and secondly to city ontology, while having no relationship with the digital space (Komninos et al., 2015). This reflects the underutilization of the potential of digital spaces and CPS, which may be rooted in interoperability problems and a lack of critical mass on the technology side of the picture and behavioral and institutional hindrances on the social side of the picture. This highlights the importance of seeking synergies between SCO and S-D logic, as their connections—epitomized by the four categories discussed above—seem to lay at the heart of real-digital intersections.

We can take both a short- and long-term view of the issue of smart urban development. The short-term view emphasizes the need for applications that create a critical mass of users in order to build feasible systems. However, the short-term view easily leads to a narrow focus on stand-alone solutions, which will not benefit from the most important aspect of SCO: integration, platformization, and the utilization of both urban and global service ecosystems. Thus, the creation of high-impact smart city applications requires the design of groups of applications working together on platforms instead of stand-alone solutions; engaging communities from large-scale urban entities such as city districts, clusters, and communities of users; targeting solutions that sustain up-skilling of human capital; and prioritizing applications that affect the city's innovation system rather than only the daily working of the city. One of the obvious needs in this respect is to seek the input and advice of urban development and innovation experts, user involvement, experience design, and crowdsourcing to increase the probability of discovering ideas and insights for innovation (Komninos et al., 2015). Such results are highly relevant for the development of public services, since they imply the relevance of the context that conditions the value co-creation within the S-D logic-oriented service system with the CPS platform as its facilitative core.

Technology plays a critical role in the production, delivery, and consumption of services within increasingly complex service environments (Peters et al., 2016). As illustrated by our cases, however, there are two significantly different contexts for technology deployment and utilization, one creating operational systems through algorithms and the other facilitating participatory practices with the help of ICTs. Accordingly, smart city-oriented S-D logic in services should approach the service development from two fronts: by developing smart systems that improve the quality of community life through urban intelligence, and by utilizing "soft smartness" through crowdsourced sensing and collaboration and other forms of Web-enabled collective intelligence. These two forms make a fundamental dichotomy of CPSPS, the first referring to (a) an administratively oriented complex service system with more or less passive service beneficiaries, the second referring to (b) a participatory or enabling CPS, which in essence has an interactive dyadic relation as its ultimate ontological core. Both serve local resource integration and the creation of public value.

The contribution of smart city discourse to S-D logic-based value co-creation in the public domain has its *a priori* conditions and limitations, as evidenced by an analysis of the low-impact problem of smart city applications (Komninos et al., 2015), including incrementalism, disconnectedness, knowledge management problems, and underutilized transformation capacity. In general, smart city applications have tended to address narrowly defined urban problems and introduce small-scale novelties, which hint at the underutilization of the potential of digital spaces and CPS. This is a critical issue when assessing the potential of value co-creation along S-D logic in smart environments.

To sum up, the previous discussion hints that most of the low-impact problems fall into the intersecting areas of service and smart city ontologies. Concerning the category of services, rather than focusing on smart stand-alone solutions, the S-D approach to value co-creation in the public domain urges us to seek systemic and functional interdependencies in service systems development, including system interoperability within and between digital spaces, inter-space integration, the upskilling of human capital that is needed in co-creation process, and the engagement of citizen-customers as active and responsible tax-payers, users, co-producers, and civic innovators. Beside services, this points to the role of knowledge in smart service design and implementation. Another knowledge-related issue is the need to pay special attention to transformational capacity rather than support to the existing systems and the daily work of city service machinery. Such a finding shows the relevance of the contextual approach to smart public services, as the interplay of systemic interdependencies and human responses to them conditions the value co-creation within the S-D logic-oriented public service system. A third category, people, which has already been referred to several times, implies that it is multi-dimensionally related to the development of smart urban services. The role of people varies from recipient to co-creator depending on the nature of the public service, the former requiring that attention is paid to value created in the passive or active use of the service in the given situation and the latter to the facilitation of value co-creation within a broader service ecosystem. Lastly, probably the most critical issue is to what extent smart urban services are developed with regard to resources available in the broader service ecosystem. This is an instance where the design of CPS becomes a critical facilitative structure. The systemic and control-oriented side of the service continuum focuses more on ecosystem-level integration with the help of artificial intelligence, while the user-involving approach of enabling local government leans naturally more to the people-oriented side of service design, together with sophisticated knowledge facilitation.

2.7 Conclusion

Technological advancements play a key role in service innovation, which drives service transformation. Cyber-physical systems offer ways of describing the technologically supported contextual service systems, which are a precondition for improved outcomes for value co-creation within such systems. Such an approach requires a contextual view of services, as offered by service-dominant logic. An additional element of this picture in our analysis is our focus on public services, which identifies a specific domain with its special principles, attributes, and relationships. Within such a conceptual field, we aimed to highlight how smart services could benefit from S-D logic-oriented value co-creation in the public domain. We identified four areas in which such a connection can be found—(a) the engagement of people, (b) smart services, (c) knowledge function, and (d) the service ecosystem—and illustrated their manifestation in two real-life smart service applications. Our conclusion is that a contextual understanding of value co-creation in public services requires that smart city applications have a strong systemic dimension that is coupled with a human dimension through genuine mechanisms of citizen engagement. Developers of smart public services may be tempted to seek quick solutions through stand-alone applications, but in the long run mechanisms that facilitate resource integration within facilitative CPS and a wider service ecosystem provide the best chances for service transformation that has the potential for major advances in value co-creation in the public domain.

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