Operating without operations: how is technology changing the role of the firm?

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Abstract

Purpose: The history and future of service operations are analyzed, with the goal to identify key theoretical and technological advances, as well as fundamental themes that can help to imagine the future of service operations in 2050.

Approach: A review of the service operations literature was undertaken to inform a discussion regarding the role that technology will play in the future of service operations.

Findings: The future of service operations is framed in terms of three key themes—complexity, orchestration, and elasticity. The paper makes three contributions to the service science literature by: (1) reviewing key themes underpinning extant service operations research to frame future trajectories of service operations research; (2) elaborating a vision of service operations in 2050 based on history and technology; and (3) outlining a research agenda for future service operations.

Originality: Service operations in the next 30 years will be very different from what it was in the past 30 years. This paper differs from other review papers by identifying three key themes that will characterize and instill new insights into the future of service operations research.

Paper type: Conceptual paper.

Keywords: Operations management, operations strategy, service operations, service systems, technology.

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A visit to Disneyland Tokyo in 2050...

Yuriko meets her friends at 8:55am on Saturday, just before the gates open. At 9:00am, they walk through the gates together, and receive a schedule of activities that has been tailored to their individual and collective emotional state over the past week, as well as their mutual interest in Japanese Manga. They always find available seats, just enough for the group. They never queue at any attraction. Following the schedule they received, they enjoy the morning parade, run into friends from school, chat over shared lunch, and pose for photos with their favourite characters. At the end of the visit day, they bow to each other and turn to leave.

Yuriko turns off the 5-D simulator in her house. She does not need provide feedback on her experience as her emotional and cognitive responses have already been captured and uploaded to all of her social channels and her publicly available medical profile. She receives notification that the cost for the day at Disneyland Tokyo Virtual has already been deducted from her bank balance as her satisfaction levels had exceeded the company's minimum guaranteed levels.

Yuriko receives an invitation to join her friends again next week. Unfortunately she has another appointment at that time and will not be able to attend, but that does not have to impact on her friends. The system gives her the option of allowing her virtual avatar to participate instead. She agrees, and schedules a time to review the highlights after the event. The system learns from her reactions to the highlights, and tweaks her virtual profile, making it ever more indistinguishable from the real her. She pauses and wonders whether she should have let her friends know that it was not really her, but then, she notices that one of her friends posted an image to one of her social channels of her at lunch with another group of friends while she was supposed to be at Disneyland Tokyo. She smiles and wonders what her great grandparents would have thought of how firms operate without operations in 2050.

Service operations research has been concerned, since its inception, with backstage processes that support and coordinate front-stage processes to deliver customer-centred services (Leffingwell, 1917). Evolving as a major sub-field of operations management, early contributions conceptualized service operations in terms of production processes (Chase, 1978), and subsequent efforts have focused on optimizing and improving the efficiency and effectiveness of these processes (e.g., Maister, 1985; Larson, 1987, Heskett, 1997; Norris and Bockelmann; Roth and Menor, 2003). More recently, the introduction of service science (Spohrer and Maglio, 2005), service-dominant logic (Vargo and Lusch, 2004), and servitization (Neely, 2008) has recast service operations in a different light; rather than focusing on exploiting production capabilities for efficiency gains, service operations is increasingly concerned with value creation in the context of coordinated firm, customer, and system or ecosystem activities (Chase and Apte, 2007). A turning point has now been reached in the understanding of service operations. However, to make a leap to 2050, it is necessary to better understand the evolving needs and capabilities of all stakeholders within a service system, and within the broader context of a business ecosystem, to shape arrangements of stakeholders to take advantage of available capabilities for mutual value creation (Lusch, 2011).

Technological advances, such as smart sensor technologies, high speed wireless communications, robotics, and artificial intelligence have created unprecedented levels of efficiency and extraordinary opportunities for innovation in general, and technology-enabled value co-creation, in service businesses in particular (Roth and Menor, 2003; Chase and Apte, 2007; Breidbach and Maglio 2016; Huang and Rust, 2018). Instant and global information-sharing, the internet of things, big data analytics, deep learning, and other current technologies already help actors within service systems to better anticipate customer needs and provide faster, more accurate service solutions that create more overall value than ever

before (Peters et al., 2016; Antons and Breidbach 2018). Looking to the future, the impact of new technologies – such as virtual reality, quantum computing, and other innovations – is not easy to predict. Nevertheless, technological advances are expected to unlock previously unimagined opportunities for value creation, but in doing so, these advances are also likely to raise important questions regarding the role of humans in the future of service operations (Ransbotham et al., 2017), and indeed within society more broadly (Espinel et al., 2015). The increasing trend toward the fusion of people and technology, ubiquitous storage and connectivity, more effective use of big data and artificial intelligence, and digitization of matter are important for the future of service (Larson, 2016; Maglio, Kwan and Spohrer, 2015; Breidbach et al. 2013).

Against this backdrop of transformations, this paper discusses the history and future of service operations, aiming to identify key theoretical and technological advances along with fundamental themes that can help to imagine the future of service operations in 2050. In the future, key service management issues will relate to orchestration of activities and resources, complexity of interactions among varied stakeholders, and the elasticity and governance of systems (and systems of systems), particularly in the context of data analytics, deep learning, and autonomous technologies. Service operations in the next 30 years will be very different from what it was in the past 30 years. The challenge is to focus not so much on technologies, but on operational issues facing firms, and how these will change. In the end, three contributions to the service science literature are provided: (1) a review of the big ideas of service operations research as a starting point for framing the future of service operations research; (2) elaboration of a vision of service operations in 2050 based on history and technology; and (3) an outline of a research agenda for future service operations.

Looking back at service operations research

The literature on service operations is vast, with dedicated literature reviews including detailed classifications of service operations research (Machuca et al., 2007; Smith et al., 2007), historical accounts of the emergence and development of key ideas (Chase and Apte, 2007; Heineke and Davis, 2007; Victorino et al., 2018), as well as more critical reviews that identified gaps as a basis for outlining research agendas (Bretthauer, 2004; Chase, 1996; Hill et al., 2002; Jonhston, 1999; Roth and Menor, 2003; Field et al., 2018).

In the first half of the 20th century, the main approach to service operations was to apply principles of scientific management, for instance, to find routines that could be remembered and learned to improve efficiency (Leffingwell, 1917) or to manage customer variability on a case-by-case basis (Leffingwell and Robinson, 1943). At the same time, a number of firms introduced service innovations aimed at improving operations and profitability: Disney's innovations including managing customer total experience by offering carefully designed themed lands, training employees through Disney University, casting employees as actors to play specific parts, and providing employees with rigid scripts to follow in interacting with customers; and Holiday Inn's innovations included standardization of the customer lodging experience throughout its multiple hotel locations (Chase and Apte, 2007). Later, McDonald's pioneered the production-line approach to service, incorporating (1) standardization and reduction in the variety of products, (2) simplification, standardization and automation of processes so that workers with limited skills and training can reliably produce quality products and deliver high quality service; (3) monitoring and control of process performance (Norris and Bockelmann, 2000).

In the 1960's, interest turned to the economics of service, for instance, with studies exploring the growth of productivity and in comparing manufacturing and service industries (e.g., Baumol and Bowen, 1965; Fuchs, 1965, 1968). In the 1970's focus shifted to customer

experience and service design, particularly by adapting methods from manufacturing (e.g.,

Levitt, 1972; Shostack, 1977, 1984), and to categorizing services by specific attributes and

dimensions (see Sasser 1976). Chase's (1978) customer contact theory grew out of this trend

toward categorizing services, in this case by amount of customer interaction with the firm;

later work added the use of technology into customer contact theory (Froehle and Roth,

2004). In the 1980's others took different approaches to categorizing services, for instance by

intensity of firm-side labour (Schemner, 1983), or by the nature of the service and its delivery

(Lovelock, 1983).

There was also a new focus on queuing, moving from a mathematical approach to a

psychological one in which expectations and perceptions matter more than absolute wait

times (Maister, 1985; Larson, 1987), and on tools to match service capacity and service

demand, such as yield management (Kimes, 1989). In the 1990's, the service profit chain

connected employee satisfaction to customer satisfaction (Heskett et al., 1997), recovering

from service failure depended on empowering service workers (Hart, 1990), and minimizing

failures or errors relied on automated methods in delivery (Chase and Stewart, 1994). Over

time, it seemed that that technology was enabling services to become more and more

disaggregated, even on a global scale, requiring substantial communication and coordination

(Apte and Mason, 1998), and providing opportunity for mass customization of service

experiences (Pine and Gilmore, 1998). Ultimately, lean management and related ideas were

applied to service (Ahlstrom, 2004; Womack and Jones, 2005), as was behavioural

operations, which take account of human cognitive and other limitations (Chase and Apte

2007; Gino and Pisano, 2008), and product-service systems and servitization, which

emphasize the coordination of goods and services (Baines and Lightfoot, 2013; Kowalkowski

and Ulaga, 2017; Mont, 2002) and which represents the movement from material-intensive

manufacturing to information-intensive services (Karmarkar et al., 2015) and knowledge-

based services (Pemeder et al., 2003). More recently, service operations have been viewed as

a part of value co-creative processes of customer, provider, and their interaction (e.g., Payne,

Storbacka and Frow, 2008; Sampson, 2012).

Key themes in service operations research

In a recent review in the *Journal of Service Management*, Victorino et al. (2018) noted that

reviews ought to adopt a more interdisciplinary approach to understanding service operations

from related fields such as marketing, human resources, and information systems, reflecting a

more service science perspective (Spohrer and Maglio, 2008). In what follows, themes are

identified that last over time and span disciplines, aiming to identify the meta-level

phenomena that the field of service operations has been built on, and will continue to be built

on, as well as the related assumptions that underpin them. Identifying these phenomena and

corresponding assumptions is critical to understand the future of what service operations may

look like. There is irrefutable evidence that changes in phenomena often challenge prior

assumptions, which in turn prompt disruption and give rise to the emergence of unforeseen

trends of changes. For example, new technologies are changing market structures and

challenging prior assumptions about power distribution in service systems (Fehrer et al.,

2018), enabling new business models that challenge the role and importance of stakeholders

in service systems (Andreassen et al., 2018), and more fundamentally may represent an

inflection point for the service sector similar to the industrial revolution in manufacturing

(Wirtz et al., 2018). Given the interdisciplinary nature of service operations, it is also

important to highlight that marketing, human resources, and information systems, as well as

service science, all draw upon theoretical knowledge outside of the business and management

discipline, such as psychology, sociology, engineering, as well as science, technology, and

society studies (Maglio and Breidbach 2014). The paper begins by identifying the key roles

and relationships of people and technology in service operations, incorporating examples

from Field et al. (2018), which also explored the future of service operations research.

People in service operations

Involving people, particularly customers, in the production or delivery process is one of the

defining features of service operations research (Chase and Apte, 2007). Customers present

challenges for service operations that do not exist in manufacturing because people create

uncertainty and unpredictability, which must be managed or controlled (Leffingwell and

Robson, 1943). Acknowledging challenges caused by the presence of people in service

operations is reflected in many articles, and perhaps best captured in the title, "Where does

the customer fit in a service operation?" (Chase, 1978). Attempts to control human behaviour

in service operations have extended to employees, through efforts to script and standardize

their actions (e.g., Disney and McDonalds). The conceptualisation of human involvement

increased in sophistication through the investigation of psychological aspects of human

behaviour in relation to queuing (Maister, 1985; Larson, 1987), through a more humanistic

approach to employees that highlighted the importance of their satisfaction to successful

service operations (Heskett, 1997), and most recently, through the application of behavioural

science principles to understand human decision-making, especially the role of biases, the

limits of rationality, and the importance of social norms (Chase and Dasu, 2001). Groups or

organisations of people may also be considered behavioural entities (Gino and Pisano, 2008),

which, through collective social norms and emergent patterns of behaviour, extend the focus

of service operations beyond the conventional individual actor or firm.

Three assumptions that have been central to investigations of service operations may

not hold in the future. First is the assumption that customers bring uncertainty and

unpredictability to service operations. Customers arrive for service at different times and at

different rates, customers have different skills and different expectations, and customers have

different preferences (Frei and Harker, 1999). But will this assumption necessarily hold true in the future? Given the proliferation in technologies aimed at understanding and predicting human actions, particularly collection and use of data and deep learning, it is questionable if uncertainty will remain a key problem. And if a need to respond to uncertainty does persist, it is clear that these technologies are also capable of accommodating high levels of variability and heterogeneity.

The second key assumption about the role of people in service operations is that there are two basic categories of people, employees and customers. Yet even three decades ago this distinction was being challenged by the argument that customers should be viewed as "partial employees" (Mills and Morris, 1984). More recently, service-dominant logic refers to "actors" in interactions for resource integration and value co-creation, rather than to customers and employees (Vargo and Lusch, 2016). Field et al. (2018) acknowledge the importance of reflecting upon the roles and responsibilities of customers and employees, but this paper questions whether these categories will be the most useful or most appropriate for understanding the role of people in service operations in the future. For example, the emergence of the sharing economy has already blurred boundaries between the roles of actors in service ecosystems (Breidbach and Brodie 2017). As a case in point, an individual could simultaneously be an employee of a sharing economy platform provider (i.e., Uber), be a customer by using the ride-sharing application, or even provide the service by becoming a driver. The tendency for roles to be reconfigured holds true in other service contexts, for example in 'M' and 'T' business models where the importance and role of middlemen is being challenged (Andreassen et al., 2018).

The third assumption is that people represent the most important actors in service operations (Chase, 1978; 1983). In the subsequent sections of this review, attention is given to the expanded role of technology, and question the conceptualisation of people and

technology as separate actors. Assumptions about the nature of human involvement in service have been observed to change over time, for instance, from rational decision making to behavioural operations (Gino and Pisano, 2008) and from the individual actors to collective units of behavioural analysis (Li and Choi, 2009). Will future characteristics of human involvement in service operations also need to be revised? Will it be necessary to develop new theoretical frameworks to capture the changing nature of the unit of analysis (i.e., from individuals to groups to systems)? Given that heterogeneity arising from human involvement has occupied service operations researchers throughout history, any change to this fundamental operating assumption would represent a critical shift in the focus of service operations research and practice. This assumption regarding human involvement is already beginning to erode in relation to employees through their replacement with service robots, a trend that is only likely to increase in the future (Chui et al., 2016; Wirtz et al. 2018).

The role of technology

Broadly speaking, technology may be defined as the application of a scientific principle to solve human problems or satisfy human needs (Arthur, 2009). Using this view, this paper distinguishes between technology as techniques or principles, and technology as machinery or systems. Technologies used in service operations are often thought of as tools to manage or control, to predict, or to design service processes. The most notable conceptualization of technology in service operations is Froehle and Roth's (2004) extension of the customer contact model according to the different roles technology can take. Yet the pace of technological change, exemplified by machine learning and quantum computing, as well as innovations such as the blockchain and cryptocurrencies, suggests that technology will present numerous opportunities and challenges to service firms in the future.

The emergence of these new technologies may render old ones obsolete, and may lead to the development of new technologies. Moreover, access to technology may put customers

rather than firms in control of how technology is used to facilitate services. This raises

numerous questions. Will existing taxonomies regarding the nature and role of technology be

sufficient? Will customer contact take new forms based upon newly emerging roles for

technology, or on new ways of accessing technology? This transformation is already starting

to take place in hospitality operations, for example, where sophisticated yield management

systems analyse operational, environmental, and customer feedback data in real-time to

predict, create and deliver better tailored customer experiences (Kandampully et al., 2016).

The relationship between people and technology

There is a clear distinction made between people and technology in the prior literature on

service operations. Technology is implemented to control or enable human action. By

contrast, some have highlighted how viewing technology as enabling and constraining human

action is just one of a number of different ways to conceptualize the relationship between

people and technology (Ellway and Walsham, 2015; Orlikowski and Scott, 2008). In

particular, sociomaterial approaches to understanding technology in organizations and society

rejects the separation of people and technology as discrete entities, emphasizing instead intra-

actions through the fusing of the two. This is not simply an abstract philosophical

consideration. It has immediate consequences for the nature of real world phenomena. For

example, Orlikowski and Scott (2015) examine the changing nature of service in the

hospitality industry using a socio-material lens to show that users of Internet services are

inseparable from the algorithms used, noting also the difficulty in studying these phenomena

and understanding their effects given this inseparability. The emergence of new phenomena

such as digital twins and automated social presence in technology-enabled services (Bolton et

al., 2018) is a further example of how the conceptualisation of the relationship between

technology and people may need to be rethought.

There are two clear implications for the future of service operations. First, this review

reveals the implicit, and usually taken-for-granted assumption in prior service operations

theorizing humans and technology as separate and discrete entities; and second, the review

suggests that it may be necessary to position technology as an equally important actor,

alongside humans, in the study of service operations in the future. A summary of the key

findings from the literature review, as well as the key questions that it raises for the future of

service operations research is provided in Table 1.

"Insert Table 1 here"

Looking forward: Future of service operations

Service operations have changed dramatically over the past 100 years. Whereas firms once

controlled operations largely internally, with well-defined relationships to outside suppliers

and other stakeholders, modern service providers *orchestrate* the actions of varied

stakeholders both inside and outside the firm (Normann and Ramirez, 1993). No longer is it

possible to consider service in terms of simple dyadic interactions and relationships – service

occurs in a *complex system* or ecosystem of multiple stakeholders (Maglio, Vargo, Caswell

and Spohrer, 2009; Vargo and Lusch, 2011). No longer are traditional notions of ownership

or firm-based value creation relevant as resources are routinely shared among individuals and

firms, creating the need for flexible or *elastic* relationships (Dustdar et al., 2011). The

boundaries between providers and receivers (rather than firms and customers) are blurring,

and the boundaries between people and technologies are blurring (Moldovan, Copil and

Dustdar, 2017). In this section, three emerging themes from the literature that are likely to

inform the future of service operations research are described: complexity, orchestration, and

elasticity.

Complexity

A system is "a combination of interacting elements organized to achieve one or more stated purposes" (ISO/IEC, 2008). Human-designed systems, such as mechanical systems, have well-defined architectures and well-understood operational mechanisms. For other systems, parts may be designed, but the systems themselves, such as cities, may evolve with architectures and operational mechanisms emerging over time. Service systems are an example of such an open system, where configurations of people, information, organizations, and technologies need to operate together for the creation of mutual value (Maglio et al., 2009). Service systems tend to fall between fully-designed and fully-emergent systems, and provide the basic abstraction for service operations management (Spohrer and Maglio, 2008).

As with many other systems, service systems are complex (Tien, 2008; Briscoe et al., 2012), which means these systems are intrinsically difficult to model and manage because of interactions among their elements, and because the behaviour of the system cannot simply be inferred from behaviour of its elements (Bar-Yam, 2003). This is true of service systems in transportation (Pelletier et al., 2011), healthcare (Tien, 2009), telecommuncations (Ellway, 2016), energy (Strasser et al., 2015), hospitality (Kandampully et al., 2015), and manufacturing industries (Meier et al., 2010). For example, new technology-enabled services are increasing the complexity of the customer experience and connecting previously distinct digital, physical and social realms (Bolton et la., 2018), service work may increasingly be nested within complex self-adjusting service work ecosystems (Subramony et al., 2018), and ongoing changes in service ecosystem contexta trigger innovation which in turn may lead to further complexity (Edvarsson et al., 2018).

Unlike the connectivity among elements in fully-designed systems, the socio-technical nature of service systems contributes to the intangible and emergent nature of the

connections among its elements (Maglio et al., 2015). Accordingly, one difficulty in

operating complex service systems is the lack of capability to monitor and manage

complexity in an automatic or semi-automatic manner. Recent technological advances,

however, have contributed to enhancing the connections among system elements, the

collection of data from elements, and computation and communications among elements for

efficient decision making within modern complex service systems (Lim and Maglio, 2018).

These advances assist with monitoring and managing the complexity of service systems for

value creation (Maglio and Lim, 2018). Examples include monitoring and prevention of

automobile problems (Lim et al., 2015) and human diseases (Lim et al., 2018).

Enhanced connectivity is facilitated through new objects (e.g., devices and servers)

and new organizations (e.g., data management and analytics companies), which add further to

the complexity of service systems (Breidbach et al., 2013). In this regard, another difficulty in

operating modern complex service systems is the necessity for intermediaries, either

individuals, organizations, or technologies, to facilitate reliable, trustworthy and seamless

interactions and operations within system networks (Breidbach et al., 2016). Examples of

such intermediaries are banks and IT platform companies. Banks connect investors and

investees and manage financial transaction data, and IT platform companies connect users

and organizations and manage huge amounts of interaction data (Breidbach and Ranjan,

2017).

Despite enhanced connectivity in modern service systems, the security and privacy of

interactions within systems often needs to be managed by intermediary organizations or

technologies (Lim et al., 2017), thereby possibly generating inefficiencies in operations and

unnecessary transaction costs. However, emergent technologies such as blockchain can

reduce such inefficiencies and transaction costs by enabling direct and secure interactions

among elements in a service system, and minimizing the roles and authorities of traditional

intermediaries (Risius and Spohrer, 2017). From its initial application to cryptocurrencies (Nakamoto, 2008), it is possible to see how this disruptive innovation can substantially reduce the complexity and inefficiency in service systems, and dramatically change the landscape of service operations in financial (Guo and Liang, 2016), energy (Hukkinen et al., 2017), consumer electronics (Lee and Pilkington, 2017), manufacturing (Abeyratne and Monfared, 2016), and other industries (Hull, 2017; Iansiti and Lakhani, 2017).

In the new context of peer-to-peer direct value co-creation enabled by connection, and with emerging technologies such as blockchain, the important question in managing complex service systems becomes "where does the firm fit in a service operation?" rather than "where does the customer fit in a service operation?" (Chase, 1978). Traditionally in disconnected networks with centralized intermediaries, customers depend on the economic activities of firms, and improving the operations of firms was important. However, in the upcoming connected, decentralized networks, such dependency is minimal; firms should position themselves in the network of the economic activities of customers, and facilitating value co-creation without operations will be crucial.

How can future researchers approach this new context of complex service systems? Future research needs to start by defining and describing the nature of complexity. In particular, how will this affect the design and operation of service ecosystems? How elastic, decentralized, and autonomous will the service systems of the future be? And how will manage orchestration and governance across increasingly complex and dynamic networks of collaborators be managed to co-create value in the future?

Orchestration

Service orchestrators seek to respond to the increased complexity of service operations by facilitating resource integration, and thereby value co-creation between *other* interdependent

actors within complex service systems (Breidbach et al., 2016). The role of service orchestrators (usually human or organizational actors), can be distinguished from the practice of service orchestration, which may be accomplished by technology. In this way, the concept of service orchestration resembles network orchestration, which is defined as the process of assembling and managing an inter-organizational network to achieve a collective goal (Paquin and Howard-Grenville, 2013), in which the legitimacy of different roles are only established when accepted by the other network members (Müller-Seitz, 2012).

Value creation is always at the core of service systems, and thus management of operations within complex human-centred service systems requires an understanding of individual values and multiple stakeholder perspectives (Maglio et al., 2015) - even when the needs of stakeholders are hard to model and study. The complexity of service systems is reflected in the physical, informational, and interpersonal interactions among people, organizations, and technologies (Glushko, 2010; Sampson, 2012), where these interactions and the associated trade-offs that are made by the different stakeholders combine to form a value constellation network for a service system (Kieliszewski et al., 2008; Patrício et al., 2011).

Value creation in such service systems is also complicated by the multi-level, multi-agent, and multi-disciplinary nature of such interactions (Spohrer et al., 2007; Joore and Brezet, 2015). Service systems have at least three levels of analysis: service ecosystems (Lusch et al., 2016), business systems (Maglio et al., 2009), and automated service functions (Erl, 2004). Service ecosystems involve dynamic interactions among different agents (Lee et al., 2012), such as suppliers, customers, and intermediaries, who perform specific processes within the systems (Payne et al., 2008; Lim et al., 2012). Different disciplines have varying scopes and foci in studying the same service systems. For example, marketing has a customer-oriented perspective on service systems (Chandler and Lusch, 2015), information

systems takes a resource utilization viewpoint to service systems (Lusch and Nambisan, 2015), and operations management emphasizes the modelling of service systems through tools such as stochastic and combinatorial optimization models (Hillier, 2015).

Rather than individual human actors, business marketing and organizational studies typically refer to organizational stakeholders (lead firms, hub firms, etc.) when discussing orchestration activities. Research on orchestration of intentionally created networks assumes that the lead firm is able to purposefully influence and manage its network (Dhanaraj and Parkhe, 2006; Hinterhuber, 2002; Lorenzoni and Lipparini, 1999; Müller-Seitz, 2012), that is, intentional networking and orchestrating value through deliberate activity. It resonates with studies of networks that adopt an actor-defined perspective, such that a central network actor strives to configure its business relationships through networking activities (e.g., Jarillo, 1988; Perks et al., 2017).

Dedicated employee roles intended to orchestrate value co-creation have been considered in several service contexts, such as retailing (Bradford and Sherry, 2013), real estate (Natti et al., 2014), and consulting (Breidbach and Maglio, 2016). However, none of these prior contributions have explicitly described or explored the role of service orchestrators, or the practice of service orchestration. Breidbach et al. (2016) found that the introduction of case managers, a type of service orchestrator increasingly common in hospitals for example, was associated with greater patient satisfaction and staff perceptions of patients' involvement in value co-creation processes as well as with higher process efficiency and staff productivity in clinical departments.

Beyond the role of the orchestrator, organization studies have also identified several orchestration processes that contribute to value creation within complex service systems, including the management of knowledge mobility, innovation appropriability, innovation leverage, innovation coherence, network membership, and network stability (Dhanaraj and

Parkhe, 2006; Nambisan and Sawhney, 2011). Effective orchestration requires processes that

enhance the ease with which stakeholders can access the knowledge and expertise of other

stakeholders (Kale, Singh, and Perlmutter, 2000), promote the equitable distribution of costs

as well as benefits (Teece, 2000), and preserve the stability of the network by encouraging

stakeholders to consider and respect the needs of other stakeholders (Kenis and Knoke,

2002). The cost of leveraging knowledge and resources increases as the network grows

(Iansiti and Levien, 2004), requiring effective processes to ensure openness and transparency

in the sharing of information (Lorenzoni and Lipparini, 1999), and for managing the

coherence and coordination across stakeholders to reduce inefficiencies and ineffectiveness in

the acquisition and application of new knowledge (Bullinger, Auernhammer, and

Gomeringer, 2004).

Future research needs to focus on expanding the evidence base. Conclusive empirical

and theoretical insights, as well as normative guidelines regarding the effective orchestration

and facilitation of value co-creation processes in complex service systems, are required to

realize the practical value of orchestration. Such guidance has been unavailable to date

(Bowen 2015; Ostrom et al. 2015). This research should explore coordination mechanisms

other than service orchestrators in complex service ecosystems. This could be digital or

cognitive assistance systems, such as IBM's Watson (Breidbach et al., 2016). In particular, it

is necessary to better understand how the emergence of service ecosystems could be

orchestrated and facilitated (Breidbach and Brodie, 2017), and how orchestration mechanisms

depend on the underlying platform characteristics, such as novelty and complexity. Also,

future research needs to disentangle how actors other than the lead service orchestrator can

appropriate value (Perks et al., 2017).

Elasticity

Elasticity refers to the extent to which the relationships among people and things within a service ecosystem are interdependent, exchangeable, and flexible. Elasticity can be viewed in terms of three core dimensions—resource elasticity, cost elasticity, and quality elasticity (Dustdar et al., 2011). Resource elasticity concerns processes used to allocate human and computing resources to achieve desired needs. Cost elasticity concerns the trade-off between cost and efficiency. Quality elasticity concerns decisions that contribute to the effectiveness of the ecosystem given the available resources.

Elasticity seeks to resolve tensions among human and computational actors as each strives to achieve individual goals. Requiring new methods and techniques to capture, manage, and adapt to find mutually acceptable compromises, Moldovan, Copil and Dustdar (2017) argue that elasticity represents a new approach to computing, where the goal is to optimize a complex system as a whole rather than optimizing individual processes. This approach views smart devices, hybrid computing, and adaptive, autonomous and intelligent systems as agents for value creation among actors, with traditional boundaries among computers, people, and things increasingly blurred.

A key consideration for elastic systems relates to the challenge of governance via task definition and allocation. According to Moldovan et al. (2017), the design and management of complex elastic systems requires new models of orchestration and governance, where the roles of computers, people and things are seen as being far more fluid and better able to capture the particularities and capabilities of the various elements of the network. For example, a recent study of governance within a cloud-based complex system involving a network of Internet-enabled objects revealed the need for an adaptive dynamic approach to governance that reflects inherent uncertainty associated with decision making over the lifecycle of a complex system (Nastic, Copil, Truong, and Dustdar, 2015). Uncertainties

resulting from novel interactions of things, network elements, cloud resources, and humans create challenges for governance of complex service systems. In response, the authors introduce a declarative policy language to simplify the development of uncertainty- and elasticity-aware governance strategies.

This work builds on prior research in the area of cyber-physical systems, which has attempted, in part, to recast computing in terms of the interface between the cyber and physical worlds, emphasizing the need to move beyond the human computing view where humans conceive and direct computers to control resources. While humans are likely to play a role in setting the initial rules (e.g., declarative policy language), elasticity among connected and heterogeneous service systems is likely to be managed and controlled in the future by computing agents that will use and adapt such rules to manage the increasing complexity of cloud-based and cloud-supported service systems, and to realize existing and new and unexpected value propositions (Ray, 2016). In this sense, the service system becomes a platform for enabling new value propositions via the elastic reconfiguration of existing resources and systems using adaptive and dynamic rule-based governance frameworks (Copil et al., 2013).

Future research is needed to better understand how to manage the relationships among computers, people and things. The insights provided by this new research will no doubt drive new approaches to control and governance (e.g., computers programming computers), which will in turn, give rise to important ethical considerations. It is also timely to consider the ultimate purpose of such systems. Where much of the attention of the computing literature has been on efficiency in information transfer and use, future research in the field of computing will need to accommodate elasticity in the purpose of the systems being created, particularly as these systems seek to resolve the views of actors with very different expectations. The insights from other disciplines have an important role to play, with insights

from the complementary fields such as marketing and operations management helping to

broaden the perspective of computing and resolve the inherent tensions described earlier.

How is technology changing the role of the firm in service operations?

From the discussion so far, it is clear that the key to the past and the future of service

operations is technology. In the past, there were well-defined roles for people and technology

and firms mainly managed and controlled technologies available for use in service

operations. Now, this is all changing. In the future, service operations will need to respond to

greater levels of variability, heterogeneity, changing and diffuse roles of actors, and the need

to better integrate humans and technology. Future service systems, will, accordingly, need to

facilitate the flexible or elastic orchestration of people and technologies in complex

arrangements for value creation. Consider how recent technologies help people make

decisions, take action, and assess value. It is not a big leap to imagine a future in which

technology assumes even greater prominence, blurring the role of the firm in service

operations.

Autonomous service systems provide an illustration of how technology is set to

redefine service operations in the future. Defined as systems that operate largely without

human participation and intervention (Chui et al., 2016), autonomous service systems rely on

five technology factors for creating value: (1) connection between things and people, (2)

collection of data for context awareness, (3) computation in the cloud, (4) communications by

wireless technologies, and (5) control of human and object actions (Lim and Maglio, 2018;

Maglio and Lim, 2018). Figure 1 provides a graphical summary of how these five technology

factors combine to impact value co-creation among the three key actors in autonomous

service systems—people, providers, and things.

"Insert Figure 1 here"

Connected things include tangible goods directly used by customers and dedicated infrastructures generally required by customers and providers; these goods and infrastructures can be connected to other things. Collected data include condition traces of engineered systems, event logs of business processes, health and behavioural records of people, and biological signals of people and animals; physical and social sensing from things and people within a service system produce data that indicate behaviours and operations of people, operations and condition management of organizations and things, and interactions within a service system. Computational processes involve the use of algorithms and knowledge to support decision-making; computation is a prerequisite for data and information communication in a connected network because these processes transform raw data into standardized data or information that enable machine-understandable data or human-understandable information.

Control in autonomous service systems includes typical machine-to-machine actuation, human-to-machine control, and recently available automation of human-to-human transactions and workflows enabled by smart contracts—self-executing scripts in the blockchain network of different parties; control in traditional and autonomous service systems can be distinguished in terms of variability, with the former reducing variability (e.g., ATMs covering limited options) and the latter accommodating variability (e.g., AI-based financial services investing by themselves). Technologies communicate with one another, people communicate with one another, people and technologies communicate; building on technologies for connection, collection, and computation, control and communication factors enable interactions among different aspects of any system. Any sociotechnical service system involves value co-creation, which brings different stakeholders together to produce a mutually valued outcome. Encounters

for value co-creation increase as people, organizations, information, and technologies become connected more tightly; informational or intellectual resources for value co-creation increase as systems collect and compute quality data; and the frequency and intensity of value co-creation increases as systems control and communicate efficiently and effectively with one another.

Examples of future autonomous service systems based on these five technology factors include autonomous homes, buildings, transportation, logistics, farming, and healthcare systems (Lim and Maglio, 2018; Maglio and Lim, 2018). An autonomous home, for instance, can be defined as a service system that automates various value co-creating activities (e.g., lighting, cooking, temperature control, etc.) for home owners through connection, collection, computation, control, and communications. The autonomous home can simplify the life of home owners by learning about their preferences, and then orchestrating various value creating activites in response to the changing and competing needs of different stakeholders.

An autonomous apartment in the not-to-distant future could connect to external systems to capture information on government environmental policies, and information available from external suppliers about their good and services, and then synthesize this information with information collected on home owner behavior using a network of sensors to compute the optimal combination of value co-creating activities to ensure that net benefits are achieved (e.g., household specific environmental targets), while also meeting the home owner's lifestyle and consumption preferences. Depending on the system policies (which could be set by the user, the system, or some third party, and could be fixed or dynamic), the autonomous service system could be responsible for monitoring sensors and controlling activities such as heating and cooling levels, turning appliances on and off, and even communicating with suppliers to negotiate and arrange better supply agreements. And though

this example demonstrates how a simple autonomous service system can orchestrate elastic solutions to the moderately complex challenge of environmental management within a single household, the same technological infrastructure could be scaled to afford automation and optimization at the building, community, city or even country levels.

Unfortunately, most of the prior research on autonomous service systems has focused mainly on the technology, with less on the roles and relationships with people, organizations, and the impact on value creation (Lim and Maglio, 2018). The framework depicted in Figure 1, and the three emergent themes proposed here, can provide useful tools for informing the design and management of fully or partially automated service systems in the future.

Discussion

The three themes of complexity, orchestration, and elasticity emerged from the review of service operations literature, and observations of the changing role of technology in service operations. Consider service system complexity. Unpredictability and uncertainty of individual customers may be less important than unpredictability of entire service systems. Technologies in the service system may not be entirely (or even mainly) within the control of individual firms, but rather may represent characteristics of constantly evolving service systems. Complexity is inextricably linked to the relationship between technology and people, and the almost unfathomable pace of change suggests that isolating individual interactions between technology and people will be increasingly more difficult, and that assemblages of multiple actors may be increasingly important.

Increasing complexity implies that orchestration will become an imperative. Is it too early to suggest that orchestration will replace efficiency as the key objective of service operations? Probably, especially as service orchestrators represent just one actor among many in service systems. This point of course shows again the importance of the changing

categories of actors in service operations. Given that the role of service orchestrators has already been demonstrated, it is possible to speculate what other roles or categories of actors might emerge.

The importance of elasticity also arises from complexity and orchestration. It immediately forces us to reconsider the overriding importance and objective of efficiency of service operations. And it may represent a new design decision, replacing the original choices outlined by Chase (1978) concerning decoupling and interdependence. It may also require us to consider different dimensions of elasticity or different levels of elasticity for different conditions in and across service systems. Alternatively, the complexity of service systems and of connections between service firms, just like technology, may not represent a choice or decision to be made by individual firms, but rather, configurations to be monitored, influenced, and adapted to by firms. It is in this way, that the future will require firms to operate without operations – in the traditional sense. Table 2 provides a summary of key research issues relating to these three emergent themes.

"Insert Table 2 here"

The first theoretical implication lies at the marketing-operations interface for service management: In the new context of peer-to-peer direct value co-creation enabled by technologies of connection, collection, computation, control, and communications, boundaries between the service provider and customer are fluid and vary case-by-case. In this new future fluid context, the difference between marketing and operations perspectives will not be that clear. Payne et al. (2008) showed that management of value co-creation in service requires an integrative approach to consider both provider-side and customer-side. Traditionally, the former has been investigated mainly in the operations management field

whereas the latter has been investigated mainly in marketing (Roth and Menor, 2003). However, it has been difficult to integrate the two fields in the literature, though high connectivity is essential in practice.

In the future fluid context, the two sides (and indeed the many stakeholders) will not be distinct and thus synchronization and harmonization of the two fields will be a must. Service research should provide a foundation for marketing-oriented operations management in autonomous service systems, such as human process management in the connected network, and the same for operations-oriented marketing management, such as customer experience in a real-time adaptive service environment. Of course reconciliation of the two fields is still many years away because of the variety and differences in data from the customer and provider processes (Tang, 2010). Nonetheless, the current work contributes to the literature by providing an original and unified viewpoint that connects marketing and operations management for effective management of fluid autonomous service systems.

The second theoretical implication concerns how institutions and technologies can encapsulate and automate activities to facilitate and enhance value co-creation in future autonomous service operations: Institutions define rules and practices by which individuals and groups behave and coordinate behaviour (e.g., North, 1990). Technologies make use of natural phenomena to serve human purposes (Arthur, 2009). Together these constitute foundational components of all service systems, arrangements of people, technologies, information, and organizations that create mutual value through joint action and interaction (Maglio and Spohrer, 2013). Specifically, both institutions and technologies incorporate routine knowledge and behaviours, usually simplifying tasks and freeing up resources for deliberate action, and often leading to innovation (Vargo et al., 2015). In fact, one axiom of the service-dominant logic is that "value co-creation is coordinated through actor-generated institutions and institutional arrangements" (Vargo and Lusch, 2016). Yet it is not always

clear what should be institutionalized or automated in future autonomous service operations,

or whether and when these will improve operational performance (Maglio, 2015). Little

research addresses design questions of what should be institutionalized or automated, and

under what conditions. Yet, given recognition that service systems play a fundamental role in

human wellbeing, and that service inclusion represents a moral (Fisk et al., 2018), and even

ethical (Asadi-Someh et al. 2016) imperative, design questions represent an important

opportunity for service operations researchers to contribute to this important area.

      The third theoretical implication relates to understanding data-based value co-creation

mechanisms: The design of a service system operating without operations requires several

fundamental understandings, such as understanding of the data-based value co-creation

mechanism. Studies on data-based value creation mechanisms are required to autonomously

operate service systems with data (cf. Lim and Maglio, 2018). A value creation mechanism

refers to a set of activities and resources, used by service customer and provider to jointly

perform particular functions (Payne et al., 2008; Lim and Kim, 2014). A prerequisite to

improve existing services or design new services for customers is a fundamental

understanding of the value creation mechanisms in the context of the specific service in

question (Patrício et al., 2011). Service researchers have discussed the notion of value co-

creation intensively (e.g., Galvagno and Dalli, 2014; Grönroos and Voima, 2013). However,

with few exceptions (e.g., Saarijärvi, 2011; Saarijärvi et al., 2014), the review revealed a

surprising lack of work directed at providing frameworks to help organizations manage data-

based value creation or co-creation, despite its significance in the future fluid context of

autonomous and elastic service systems.

      There are also potential practical or managerial implications. For one, increasing

automation, particularly of information actions, suggests that competitiveness will depend

more on non-information actions. Human actions in service systems can be categorized as

information, physical, and interpersonal actions (Apte and Mason, 1995), and the automation

of these actions has evolved from automated teller machines of banking services to

warehouse robots of shipping services and robots for emotional and frontline interactions.

What happens when the all firms have access to almost limitless data and almost limitless

ability to analyse it? How will firms differentiate themselves? What will be the new core

competencies? Technological advances in connection, collection, computation, control, and

communications provide service companies with numerous opportunities for operating

without operations.

Opportunities may lie not with the technology itself, but with the extended ability to

enable an autonomous value co-creation mechanism. Ironically, with complete automation,

technology may not matter much; service system design may matter more. For example, the

core utility of blockchain technology is the ability to "program" the interactions within a

service network and to "design" the value co-creation mechanism in service system, as is

currently done for electronic and mechanical systems.

Conclusion

More conventional reviews of service operations research, encompassing the field in breadth

and depth, provide invaluable resources for scholars to trace the historical development of the

discipline as well as provide detailed frameworks for subsequent service operations research

(e.g., Roth and Menor, 2003; Chase and Apte, 2007; Victorino et al., 2018). By contrast, the

approach taken here has been to identify broad themes that tie together service operations

research, question whether assumptions inherent within them will remain, and provide

evidence for already emerging trends in service and service systems. Some of the ideas,

issues, and questions articulated may well not come to pass. But accurately predicting the

future or providing irresistibly familiar classifications, frameworks, or research agendas was

not the motivation.

Rather, in this paper the aim was to draw attention to what might change further into the future. No one knows what service operations research will be in 2050 or what challenges service firms will face in managing their operations in 2050. Predicting with a high level of certainty is a risky trade, but the aim was to stimulate debate in the field and set out a new research agenda to help guide the field forward. For managers and firms, the main implication of this work is that service businesses ought to get ready to respond to the new emerging themes of complexity, orchestration, and elasticity. In the end, it is hoped only to trigger some ideas about what the practical challenges and academic questions in 2050 might be.

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Table 1. Future of Service Operations Research

Theme	Past	Present	Future
People in service operations	Service operations reduce uncertainty of rational human decision makers.	Service operations capture and respond to heterogeneity (e.g., behavioral economics) reflected in the decisions of humans with bounded rationality.	Can the delivery of services be truly automated, or is the human element and customer variability always going to be central to service operations? How will variability be managed in the future, particularly as information asymmetry declines? Are existing theoretical frames sufficient to address the expanding unit of analysis within service operations (individuals-groups-systems)?
Role of technology	Technology (techniques and principles) used to increase service efficiency and yield.	Technology (techniques and principles) is used to improve understanding and automate processes.	Who manages / governs the automated technology which delivers elastic services and addresses the complexity? What measures (dependent variables) can be used to understand the nature of service operations in the future? What is the role for orchestration in efficiency improvement of service operations in the future?
Relationship between people and technology	Humans control technologies and the boundary between the two is clearly separate.	Technology assists humans and the boundary between the two is beginning to blur.	What role will humans play in the technology-dominated operations of the future? What happens when technology replaces humans as the central actor (e.g., labor intensity, future of work)? Are there new behavioral entities that require further theorization (e.g., elastic systems)?

Table 2. Summary of research issues

Theme	Research agenda
Complexity	How firms will position themselves in the upcoming connected, decentralized service ecosystems, where the economic activities of customers little depend on firms?
	How is the nature of complexity changing, and how can future researchers approach this new context of complex service systems?
	How will emerging concepts of complexity affect the design and operation of service ecosystems?
	How elastic, decentralized, and autonomous will the service systems of the future be?
	How will orchestration and governance be managed across increasingly complex and dynamic networks of collaborators to co-create value in the future?
Orchestration	What normative guidelines can be provided regarding the effective orchestration and facilitation of value co-creation processes in complex service systems?
	What coordination mechanisms, other than service orchestrators, are required to optimize complex service ecosystems?
	How will automation technologies (e.g., cognitive assistance systems) assist in the orchestration and facilitation of value for all stakeholders of service ecosystems?
	How to disentangle the roles of actors, other than the lead service orchestrator, within new platform-based service models?
Elasticity	What are the ethical issues associated with the growing presence of technology within the service ecosystems of the future?
	What new institutional forms and approaches to control and governance (e.g., computers programming computers) are likely to emerge in the future?
	What is the ultimate purpose of complex, self-organizing service ecosystems: Who do they serve?
	Can the systems of the future adequately accommodate elasticity in the purpose of the systems being created, particularly as these systems seek to resolve the views of actors with very different expectations?
	How can insights from other disciplines be brought together to broaden the perspective of computing, and resolve the inherent tension between the role of technology and other actors?
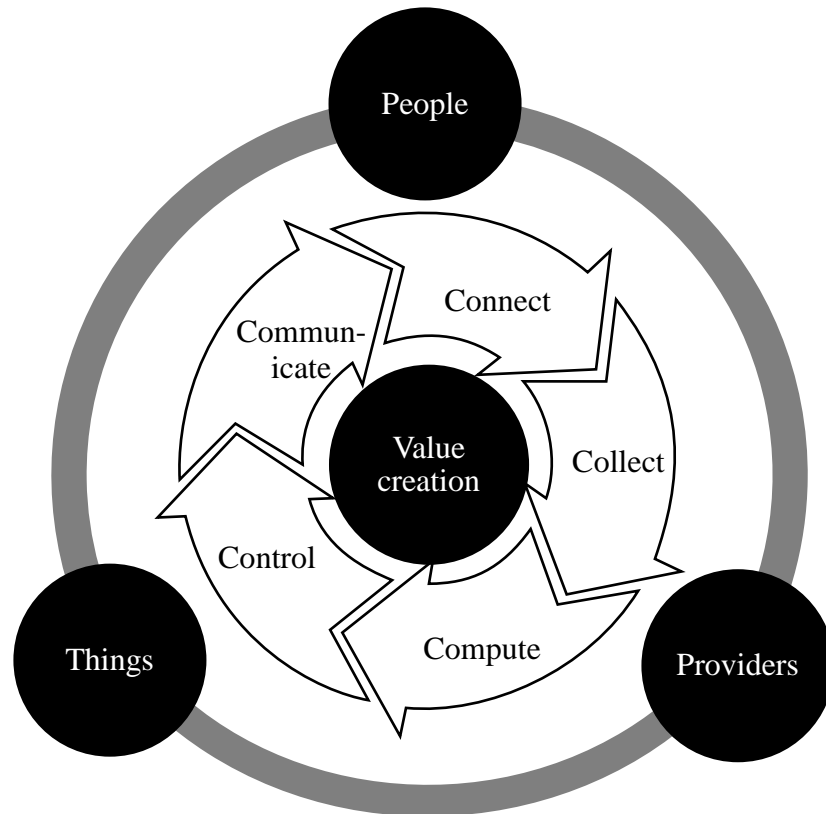
Figure 1. Autonomous service systems (Adapted from Lim and Maglio, 2018)

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