Journal of Service Manag

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Journal:	*Journal of Service Management*
Manuscript ID	JOSM-12-2018-0398.R2
Manuscript Type:	Research Paper
Keywords:	Technology disruptions, tourism and hospitality, artificial intelligence, virtual reality, augmented reality, Co-creation

Journal of Services Management

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ABSTRACT

Purpose – Technological disruptions such as the Internet of Things and autonomous devices, enhanced analytical capabilities (artificial intelligence) and rich media (virtual and augmented reality) are creating smart environments that are transforming industry structures, processes and practices. This paper explores critical technological advancements using a value co-creation lens to provide insights into service innovations that impact ecosystems. The paper provides examples from tourism and hospitality industries as an information dependent service management context.

Design/Methodology/Approach - The research synthesizes prevailing theories of co-creation, service ecosystems, networks and technology disruption with emerging technological developments.

Originality – Guest experiences in tourism and hospitality by definition take place in hostile environments that are outside the safety and familiarity of one's own surroundings. The emergence of smart environments will redefine how customers navigate their experiences. At a conceptual level, this requires a complete rethink of how stakeholders should leverage technologies, engage and reengineer services to remain competitive. The paper illustrates how technology disrupts industry structures and stimulates value co-creation at the micro and macro-societal level.

Societal Implications – Technological disruptions impact all facets of life. A comprehensive picture of developments here provides policymakers with nuanced perspectives to better prepare for impending change.

Limitations – Tourism and hospitality services prevail under varying levels of infrastructure, organization and cultural constraints. This paper provides an overview of potential disruptions and developments and does not delve into individual destination types and settings. This will require future work that conceptualizes and examines how stakeholders may adapt within specific contexts.

KEYWORDS: Technology disruptions; tourism and hospitality; artificial intelligence; virtual reality; augmented reality; co-creation

INTRODUCTION

Information and Communications Technology (ICT) is revolutionizing the development of products and services. From assembly lines to multi-stakeholder complex systems that combine hardware, sensors, data storage, microprocessors, software, connectivity and offer a new wave of smart technologies that reengineer best practice and propel service providers to optimize their performance dynamically (Guttentag and Smith, 2017). Smart, connected products accelerated by processing power and ubiquitous network connectivity restructure markets, disrupt value chains and reengineer business processes and economies (Porter and Heppelmann, 2014). This has implications in life, work and travel as it introduces dynamic formations for every aspect. This revolution is taking different forms and shapes. Increasingly economies are formed as distributed networks of owners/suppliers/intermediaries/stakeholders who interact dynamically with customers/demand over distributed platforms. In the pre-sharing economy era, when transport was offered only by authorized professionals, there was little choice other than owning your vehicle or to pay professionals and organizations to transport passengers (trains, authorized busses or taxis). In the sharing economy era, personally-owned Uber cars or dockless scooters, such as Lime and Bird in the US, have eliminated the stranglehold of transportation companies and introduce flexibly adapted shared resources, disrupting market structures and dynamics. All these require reconfiguration to become and remain competitive in

smart networked environments at the micro level reflecting structural influences of changes in marketplace practices at the macro level.

Service management inevitably has been influenced by recent technological revolutions and smartness. The availability and accessibility of services grew exponentially as customers from around the world could instantly plug and play from the emerging platforms harnessed by service providers. More importantly, the sharing economy means that customers are in a position to offer services on emerging platforms and network with others who can easily identify and use them (Guttentag and Smith, 2017). Deliveroo or Uber Eats are examples of organizations that grew rapidly to facilitate service providers to meet service requirements. A range of new business models emerged to enable the market to expand and operate. The proliferation of internet connectivity, big data and the Internet of Everything reengineer economies at both micro and macro levels, revolutionizing production and consumption.

Tourism and hospitality firms by definition offer services to consumers in hostile environments, away from the safety and familiarity of their normal surroundings, where they are distant from familiar cultures, resources and languages in the place they visit. Consumers therefore need more information to operate in hostile environments and also to maximise their value for money and time (Buhalis and Foerste, 2015). This form of consumption has been evolving with technology and the integration of ICT and eTourism (Benckendorff et al., 2014). Since the early 1960s, technology in the form of global distribution systems (GDS), booking and reservation systems (Werthner et al., 2015), social media and mobile applications (Sigala, 2018), recommender systems (Fesenmaier et al., 2006), context-driven search, search engines and Web data mining (Xiang et al., 2008), has helped consumers find relevant information and service providers to facilitate transactions. The rapidly evolving wave of technological advancements have major implications for service management and marketing and we can learn from tourism as a frontline service industry that integrates new knowledge on technological advancements in strategic planning processes (Phillips and Moutinho, 2014).

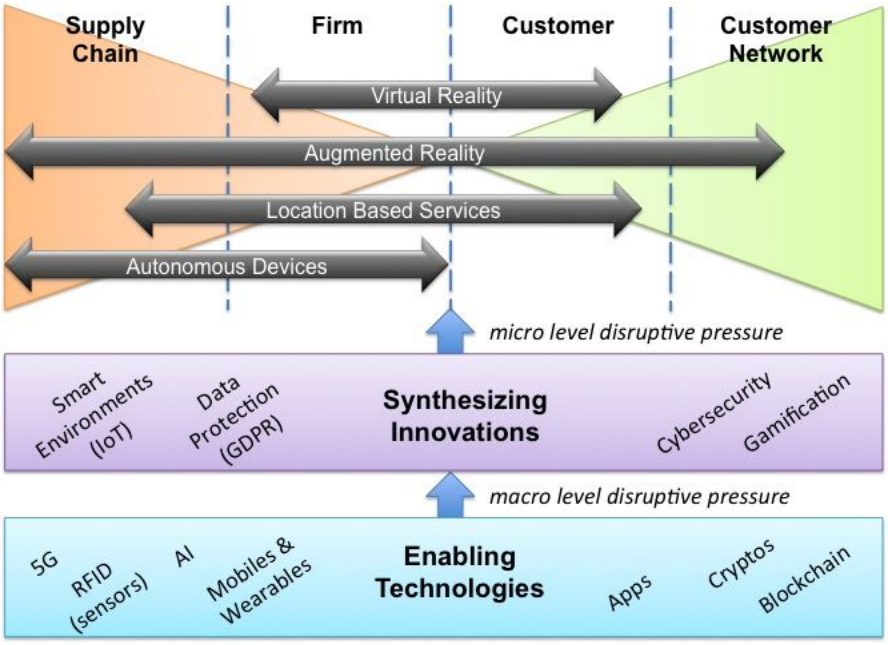
This paper offers a critical review of technology disruptions in service management and the transformation of value co-creation processes. Stemming from the viewpoint that ICTs stimulate value co-creation, this paper explores how technological advancements enable value co-creation among the actors in the tourism services ecosystem. The research illustrates how technology trends and initiatives can stimulate value co-creation at the micro-foundational level. It also explores the disruptive potential of the newly generated value in day-to-day tourism services and explains how disruptive innovation shifts the market structures at the macro-societal level. Finally, lessons are drawn from tourism and hospitality services onto broader services management and marketing. The paper conceptualizes how technology innovations and disruptions develop new service management ecosystems and examines implications for the macro and micro levels.

TECHNOLOGICAL ADVANCEMENTS FOR SERVICE MANAGEMENT

Recent technological advancements impact on service firms, customer engagement strategies and their expectations (Helkkula, Kowalkowski and Tonvill 2018). Figure 1 provides an overview of those technologies that have immediate implications for service industries, distilled from a systematic review of recent research into emerging and new technologies. A range of enabling technologies (i.e., technologies that can drive a disruptive change) support the synthesizing innovations identified that underpin the application of technological advancements applied within the firm/customer domain. These enabling technologies have unprecedented impacts at macro-societal and micro levels that create disruptions in industry structures resulting in a breadth of service innovations. Theory of value co-creation provides a useful lens by which to evaluate their impacts (Edvardsson and Tronvoll, 2013).

Helkkula et al. (2018) argue that service experience and service systems are resource integration archetypes of service innovation that have evolved as a consequence of technological advancements in recent years. The service experience archetype takes the perspective of a customer in a social context as its premise, where value co-creation may not necessarily involve a direct service and more broadly reflects Vargo and Lusch's (2008) comment "value is always uniquely and phenomenologically determined by the beneficiary" (p.7). Importantly, Helkkula et al (2018) suggest that technologies are not the central service but a means to delivering service to the customer. The service systems archetype emphasizes the social connectedness and dynamic interplay of resources, where the customer is the central actor. This draws on S-D logic as a means by which to synthesize and provide a more dynamic and holistic view of how value is co-created (Vargo et al, 2015). With this in mind, we review the technological advancements and their potentially disruptive impacts for service innovation and management.

Figure 1 Technological Advancements for Service Contexts



Enabling Technologies

Seven key technological advancements underpin current service innovations that impact firm-customer interactions with implications for service management and marketing. These are fifth generation mobile network (5G); Artificial Intelligence (AI); Radio Frequency Identification (RFID); Mobile devices, smartphones and wearables; Applications or Apps (along with APIs), Cryptocurrency and Blockchain. We first outline the technology and its service innovation potential and then discuss the service marketing and tourism management implications.

The **fifth-generation mobile network, 5G,** is a wireless telecommunications system (Enhanced Mobile Broadband, EMBB). 5G significantly influence the speed at which large volumes (gigabits) of data can be transferred across mobile networks. 5G provides the infrastructure for ambient intelligence, interconnectivity and the Internet of Things (IoT) (Palattella et al., 2016). This will support a higher level of customer engagement, with innovations anticipated in streaming services that use rich data such as

film and game. Applications empower both customer and machine-to-machine interactions and underpin the advancement of autonomous devices or agents, mission critical systems and smart environments. The technology is currently in early stages of implementation around the world and is expected to be in scalable use by 2020. Stakeholders involved include telecoms organizations, such as Ericsson, Telenor, EE, China Unicom, etc. (Fisher, 2018). 5G comprises a number of different advancements that include:

- edge computing services that connect data from remotely located sensors to wireless devices, reducing latency in cloud-based applications; and
- new types of video delivery services that are likely to compete against existing channels such as Netflix, Amazon, etc. (Fulton, 2018).

5G's immediate impact on service innovation is the speed of online content delivery to customers and support of IoT connectivity. The widescale use of 5G telecoms will enable the rapid adoption of services that make use of urban automated networks such as IoT and autonomous devices (Gomez and Paradells, 2015). The impact of 5G will be felt in all sectors of the economy from factories of the future, automotive, health, energy and media and entertainment. Predicted societal impacts on rural/urban integration, decentralization of work, reduced mobility needs, energy efficiencies, increased security, and, generally, enhanced life expectancy will be delivered through the development of service ecosystems that will be co-created between a range of different actors to deliver value for consumers (G.W. Report 2015; Neokosmidis et al., 2017). Recently highlighted international security issues with one major 5G supplier has already impacted the perceived trustworthiness of equipment leading to calls for more scrutiny in future network developments (eg., Cellan-Jones, 2019).

Artificial Intelligence (AI) was originally defined by Minsky (1967) as a technology or machine that can perform a task that, if conducted by a human, would require intelligence to complete. Subsequent definitions ascribe AI with the capacity to learn (McCarthy et al., 1955), to sense, reason and take action (Stanford, 2016) as well as to detect, deliberate and develop on its own to 'discover which elements or attributes in a bunch of data are the most predictive' (Sterne, 2017). In its current state of development, AI is a narrowly applied decision-support tool, with potential application to a broad range of business operations (see eg., Wirtz et al., 2018). Expectations for its adoption and impact on types of services offered and business processes supported are considerable in service industries. These include all information-intensive industries such as financial, professional, healthcare, public sector, energy and media/telecoms as well as service sectors (Ransbotham et al., 2017). AI application impacts information and operations management, research and development, finance and accounting, supply chain management, strategy, sales, marketing and customer services (Wirtz et al., 2018). Different types of AIs are evolving, recognized as reactive, limited memory, theory of mind and self-aware (Hintz, 2016). The latter two are arguably many years from realization, but the former two are already widely in use. For example, automated teller machines (ATMs) have been in use since the 1960s, whilst chatbots, such as Siri and Alexa are now widely adopted as customer-facing service robots (van Doorn et al., 2017), based on their ability to process large amounts of data to deliver routinized tasks. Such technologies underpin the potential for consumers to increase their rate of resource integration that makes real-time moment-to-moment decision-making scalable across social contexts (by automating processes). In investigating this it will be particularly important to correlate the ongoing technological advancement, since by their nature AIs are learning 'machines', with the so-called 'second order cybernetics', that is the observation of consumption patterns of AIs from which they learn - an inherently co-creative process.

Radio Frequency Identification (RFID) technology uses local storage on small (microchip-sized) devices enabled with near field communications. These devices sense, store and transmit environmental data (Lee et al., 2017). An already widely used technology, it is embedded within everything from credit cards

and passports, transit systems, tolls and security systems to products, hotel keys, airport luggage systems as well as pets and 'things'. In conjunction with reading devices such as smartphones and local access machines, RFID renders data held on a chip to be used in increasingly sophisticated ways, particularly when overlaid with AI technology. For example, in recognizing proximity with a geographical positioning system (GPS), applications that track movement and time can facilitate a breadth of location-based services (Cha et al., 2016). RFID embedded within emerging classes of sensors, enables smart environments, predicated on resource and operational efficiencies, but also support real-time customer engagement strategies. RFID supports the IoT, which is an emergent suite of applications and sensor-based technologies that have led to a plethora of service innovations (Harwood and Garry, 2015). The technological advancement provides the means through which customers and firms co-create a data driven experience within a cyber-physical system context. Their proliferation in servicescapes increases the volume of data and dataflow which provides the basis of socio-technical services.

Mobile devices and smartphones integrate mobile telephony with microcomputing capability. They are used by over forty percent of the world's population and in 2018 became the dominant form of internet access (Rodriguez, 2018). Smartphones have rapidly become a tool of choice by consumers, although the first smartphone was launched as late as in 2007. They are paving the way for typically disadvantaged and disconnected communities (such as those in Africa) to gain access to internet enabled services (Lanerolle, 2015). Smartphones are increasingly sophisticated technology assemblages that include cameras, recorders, GPS, sensor and wireless technology as well as host a range of APIs and Apps. In future, they will incorporate the capability to respond to individual users through facial, voice and movement recognition technology, become projectors and holographic displays and merge with wearables as they become more physically flexible in their design (Mobile World Congress, 2018). Such technology underpins the wider adoption of AR and VR, as 5G enables faster, richer content to be transmitted assimilating real-time telepresence (Wirtz et al., 2018). Development of new types of sustainable battery materials (graphene, solar, hydrogen, kinetic) mean access to charging and energy resources will change, and is also forecast to dramatically influence their further adoption and use. Wearables are a class of smart mobile device that typically employ a unique platform interface design such as a watch, tattoo or bracelet. Their ability to augment the person, underpins the so-called extended-self theory (Belk, 2016). Increasingly smartphones will interact with their context, using information proactively to feel the personalized context of their owners (eg., booking into a favourite restaurant when schedule allows) and also reactively to address unpredicted incidents in the environment (eg., heavy traffic or cancelled flight). Smartphones will become a digital concierge, interacting dynamically with all resources, to optimize the customer experience.

It is **Applications or Apps (along with APIs)** that render smartphones and wearables usable. These are designed as third-party interfaces that sit over platform technologies (hardware and operating systems). Although a familiar and well-used suite of technologies, the ongoing development of app accelerated pages, directly influenced by Google's open access Accelerated Mobile Pages project (AMP, see https://www.ampproject.org/), is envisaged to considerably enhance their performance. Hence such technology makes use of future AR and VR content possible, particularly for service management. This is likely to result in new mobile-enabled engagement strategies in everything from military, healthcare and engineering to services and education. On the Apple App Store there are over 450 recommended travel and tourism related apps related to destination points of interest, maps, personal travel guides, transport services, language and currency converters as well as specific hotel service providers. Many of these offer relatively low levels of interaction but the new classes of app, enabled through the technology developments, significantly enhance their utility (Xia et al., 2018).

Cryptocurrency is a collective term for peer-to-peer transaction of digital currency over the internet that incorporates anti-counterfeiting measures (Romanova et al., 2018). The term is a conflation of cryptography and currency. It provides a verifiable and secure track record of exchanges. Cryptos are created and controlled by algorithms that specify how transactions are made and recorded, and how new tokens (coins) are created and transferred. Each coin is created with a unique identifier using cryptography, which is added to as it is transferred and exchanged. Peers themselves are a key part of the process of recording and verifying all transactions made with each coin and effectively act as a collective bank. The process of recording is built into a 'blockchain' (cypher). **Blockchain** is a form of digital decentralized ledger technology. It is a growing list of records (blocks) that are linked (chained) using cryptos. The principle is that once written, blocks cannot be altered. Blockchain is publicly readable and distributed over a network of computers which therefore means it has no centralized authority. Collectively, it is the community holding the blocks that verifies authenticity of the chain (Lichfield, 2018), effectively co-creating collective value. Cryptos, since its emergence in 2009 (Nakamoto's Bitcoin), have become a form of common tender and are now traded on stock markets around the world. As a consequence of their scarcity and value they are positioned as a digital commodity and traded much like gold and silver. The various developments in cryptos, of which there are currently around 1300 in existence (eg., Ethereum, Ripple, Litecoin), enable new forms of transaction to take place without standard market-based intermediaries, such as banks and government bodies, as well as the attendant financial and professional services aligned to them. They are therefore a significant disruptive influence in commerce for the development of contracts and value-based exchanges between customers and firms, even when there is limited trust between the parties (Tillier, 2018). In favour of its use, there is no longer any need to worry about fraudulent exchanges or payments, because it is only possible to use crypto coins which, by inference, authenticate ownership through the transparency of blockchain records (Koenig, 2015). This makes service transactions straightforward and efficient. Its implication for service providers is profound, as they become increasingly reliant on customer engagement in service systems (Helkkula et al, 2018).

Synthesizing Innovations

The emergence of these enabling technologies has led to a series of synthesizing service innovations. Synthesis reflects a multidisciplinary and multidimensional paradigm to value co-creation (Yu and Sangiorgi, 2018; Helkkula et al, 2018). Three strategically important innovations and their implications for service industries in disrupting service management and value co-creation in the marketplace are next discussed: smart environments, cybersecurity and gamification (eg., Lu et al., 2018; Bellovin, 2018; Harwood and Garry, 2015). Although each renders different service innovations, they make use of similar technologies highlighted in the previous section. Essentially, these synthesized innovations draw on mid-range theories of value co-creation that have potential to enable empirical studies that explore and extend both theory and operationalization of the innovation (see eg., Helkkula et al., 2018). These are further explored in the subsequent sections of this paper.

Smart environments use ambient technologies (sensors, telecoms networks, IoT, AIs) to provide sustainable resource efficiencies and new insights into operations from complex data to firms and their stakeholders (Salguero and Espinilla, 2018). The Internet of Things (IoT) is a new technological paradigm that connects anything and anyone at any time and any place, giving rise to innovative new applications and services (Lu et al., 2018).

Some examples of smart service environments are in healthcare, hotels and cities. Healthcare facilities, such as hospital rooms, are being modelled with ambient technologies that assist both patients and medical staff through integrated sensor technologies (Kartakis et al., 2012). These hospital rooms allow

patients to control their environments and interact with the hospital facilities and personnel. The patient rooms are equipped with sensors to manage TVs, fluorescent lights, window blinds, hospital beds, medical devices etc. that are all integrated into a network for seamless functioning. Hotels are increasingly evaluating and testing smart environments in guest rooms to enable them to better manage their environments and co-create service innovations (Sheivachman, 2018). Both Hilton and Marriott are testing how ambient technologies can be integrated effectively with sensors on devices and equipment for guest-controlled service experiences. Singapore Tourism Board is leading the efforts in smart tourism by implementing a tourism analytics network ('STAN') to retrieve and analyse tourist data from mobile phones, transportation, traffic and safety systems. The aim of the data-driven approach is personalization of tourist offers at given time, location and price points (Govinsider, 2018).

Cybersecurity is a convergence of technologies and processes that collectively defend and protect hardware, software and data against fraudulent, damaging or unauthorized use (eg., Cisco, PwC, Kaspersky) and perform data protection by design (Binxing et al., 2018). Cybersecurity breaches using software such as malware, ransomware, spyware, etc. are common in today's market environment, and computer insecurity is a major threat to business continuity. This is, however, a limited perspective when considering the exponential growth predicted for interconnected objects, devices and people enabled through a range of emerging technologies. Increasingly, an important role of AIs will be to identify attacks as they happen and manage security in real-time; although the same technological advances are also in the hands of attackers, intimating the scale of the problem. Particularly at risk are mission and safety critical systems, such as identification, financial, energy, healthcare systems. For instance, around 500 million of Marriott's guest accounts were compromised in a recent breach of the Starwood reservation database. Panera Bread has received harsh criticism for taking eight months to resolve the leak of customer information from their online delivery system (Luna, 2018). Strong cryptographic measures are often rejected by firms because of perceived resource implications (Bellovin, 2018). Cryptos and blockchain technologies are key methods being explored to address these challenges. Calls to rethink cybersecurity are ongoing, involving multidisciplinary approaches to address challenges from engineering, networks, systems and human behavioural perspectives.

Gamification is a pervasive movement, predicated upon the incredible success of the computer games sector to engage consumers around the world through ludological experiences (Breidbach et al., 2014). Gamification is the use of game mechanics (leaderboards, achievement badges, goals, competition) in non-game environments such as websites, employee engagement processes, customer retention strategies, marketing and branding (Seiffert-Brockmann et al., 2018; Zichermann and Linder, 2011). This approach exploits the technological advancements identified including various new devices, AIs, VR, AR, etc. Gamification has a wide range of applications and support functions and has considerable potential for tourism and hospitality. For example, Club Med employed gamification in their JADE application to motivate guests of its Opio Holiday Village in Provence (France) to explore the village historic sights, sustainability initiatives and familiarize themselves with the natural scenery in AR (Atelier Nature, 2016). In the restaurant industry, Starbucks has integrated game mechanics with its rewards program and loyal customers not only receive awards, stars and badges but also menu challenges, rewards for grocery purchases and free items that further build custom. It can therefore contribute to rewarding interactions and higher level satisfaction, leading to increased brand awareness and loyalty for tourism destinations and organizations (Xu et al., 2017). There is also growing interest in how AR/VR and LBS can be integrated to increase interest in service innovations, enabled by AIs that underpin gamified experiences that adapt to idiosyncratic consumer-centric preferences.

TOURISM AS A TECHNOLOGY-ENABLED CO-CREATION ECOSYSTEM

Instead of captivating audiences via technology trends that lack true value, travel companies need to envision brands as technology-driven platforms for enhancing customer experience and value co-creation (Weissenberg, 2017). Such platforms are constituents of a tourism ecosystem that consist of micro-experiences across online travel agencies (OTAa), accommodation, transport, and destination activities. We therefore position technological advancements as an enabler of co-creation in the hostile service ecosystem of tourism.

Tourists often feel anxiety and fear from the unknown, when traveling to unfamiliar destinations (Korstanje, 2011). Rather than seen as pleasurable getaways, tourist destinations can also be alien and hostile environments, counterintuitive from tourists' ordinary surroundings. A tourist who has not visited a foreign country before can be apprehensive in interacting with unknown people who speak different languages or even restrain from eating unfamiliar food. Likewise, the process of reaching a destination with distinct cultural norms and social interaction, paying in different currency, passing through security and safety checks and preparing an emergency plan impose additional obstacles to international tourism. Although tourists are typically active participants in their own experiences (Buonincontri et al., 2017), hostility impedes their spontaneous tendency to co-create experiences. In times of catastrophes such as natural disasters or terrorist attacks, tourists are particularly vulnerable and unprepared to respond as they are unfamiliar with local environments and resources (Fuchs et al., 2013; Citibeats, 2018). Terrorist attacks have shaken the global tourism market, causing many tourists to wonder whether they should stop travelling or how to prepare for emergency situations (Liu and Pratt, 2017).

The question therefore arises: how can tourist prosume (Toffler, 1980) and co-create experiences in the service exchange process in unfamiliar and hostile environments, especially at times of unexpected events and turbulence? Providing advanced tools to support experience co-creation as well as emergency support if needed is of paramount importance. Historically, tourism has been studied as a system of multiple, interconnected service elements that when combined enable tourist experiences at destinations (Inversini and Buhalis, 2009; Mariani et al., 2013). Tourism is a highly social context, where service experience heavily relies on the interaction and shared experiences among stakeholders (Neuhofer et al., 2012). Consistent with the system theory view of tourism, service ecosystems provide a lens for understanding the interaction among institutions, people and technology in service value co-creation (Vargo and Akaka, 2012). Value co-creation across stakeholders in service ecosystems has been shifting focus from macro processes to micro foundations (Storbacka et al., 2016). Co-creation at the micro level assumes the daily service exchange processes of actors (organizations and individuals) that constitute a service ecosystem (Perks et al., 2012). Although co-creation practices have traditionally been understood as business-customer processes (Prahalad and Ramaswamy, 2004) increasingly it is customer-to-customer processes that determine the overall experience. ICTs support human actors to engage with other human actors, including other tourists, service providers, suppliers, intermediaries or even local residents. Through interaction with different stakeholders in tourism ecosystems, that includes travel agencies, transportation, accommodation, attractions, retail and food service sectors, tourists are empowered to co-create their experiences and enjoy value propositions (Buhalis, 2000). ICTs also facilitate customer-to-customer value co-creation and continue to revolutionize service management (Rihova et al., 2018). As non-human actors, ICTs change the nature of social interaction and support the evolution of co-creation ecosystems.

Building on the micro and macro-level view of service innovations, ICTs represent platforms for co-creation of value that could increase familiarity with the destination, proactively provide information and mitigate the risks to traveling and reducing perceived hostility. ICTs may also increase inclusiveness

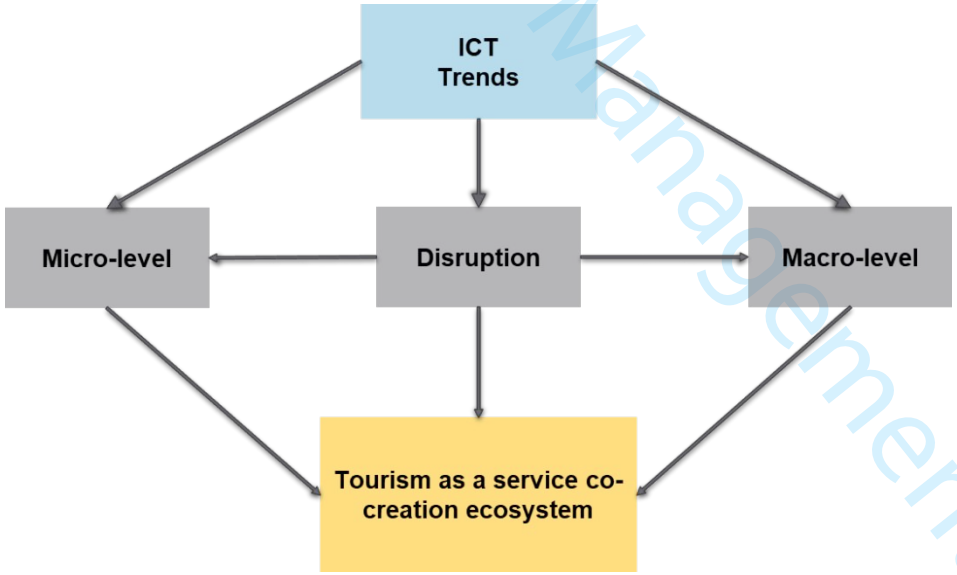
for travellers with disabilities and special needs as it contributes to accessible tourism. Individuals with mobility, visual, auditory, and cognitive impairments are often discouraged from being tourists because of the physical and service barriers at destinations (Michopoulou et al., 2015). Technology substitutes and complements human labour and averts customer service issues. For instance, individuals with mobility impairments can use VR to pre-test the accessibility of the destination and travelling process from the comfort of one's home (Weissenberg, 2017). Likewise, VR could help individuals with autism spectrum disorders (ASD) prepare for the trip by familiarizing themselves with destinations. VR destination platforms help tourists with ASD to co-create their experience and repeat it until they establish a routine (ABA, 2018) that may alleviate unpleasantness and anxiety during the actual tourist experience. A summary of literature on technology-enabled co-creation in tourism is available in Table 1 whilst Figure 2 presents a synthesis of how technology revolutions propel disruption and a paradigm shift in tourism and hospitality.

Table 1 Technology-enabled co-creation in tourism and hospitality

	Year	Author	Method	Findings
Technology enabled co-creation	2014	Neuhofer, Buhalis and Ladkin	Case studies approach	Proposed a nine-field experience typology matrix, determined by intensification of technology and intensity of co-creation.
	2014	Mohd-Any, Winklhofer and Ennew	An online survey	Develop a 6-dimension instrument for assessment of perceived e-value during customers' co-creation of travel website experiences.
	2016	Morosan and De Franco	An online survey	Mobile commerce habit affects the degree of hotel guests' co-creation which translates into the perceived value of co-creation and future behavior toward a hotel enabling co-creation via mobile technology.
	2016	Altinay, Sigala and Waligo	Semi-structured interviews	Natural, financial, political and institutional, and human capital enable social value generation in value co-creation processes at individual (micro), meso, and the macro-level.
	2016	Chathoth, Ungson, Harrington and Chan	A critical literature review	Identified three service transactions modalities, namely traditional production, co-production, and co-creation that depend on changes in consumer attitudes, enabling technologies, and ideology supporting the change.
	2017	Buonincontri, Morvillo, Okumus and van Niekerk	A field survey	Active participation in tourist experiences and interaction between the tourists and providers are positively associated with experience co-creation. Identified positive relationship among experience co-creation, tourist satisfaction, level of expenditures, and happiness. Tourist attitudes toward sharing experiences with other tourists are not associated with experience co-creation.
	2017	Zhang, Gordon, Buhalis and Ding	A scenario-based online survey	Online destination platform experience induces destination emotional experience which translates into destination engagement intentions.
	2017	Sarmah, Kamboj and Rahman	An online survey	Hotel guests' innovativeness and need for interaction with hotel staff drive adoption of co-created services indirectly, through their willingness to co-create via smartphone apps.
	2018	Rihova, Buhalis, Gouthro and Moital	Semi-structured individual and group interviews and observations	Identified 18 C2C co-creation practices in tourism context and four value-outcome categories: affective, social, functional, and network.

	2018	Bec, Moyle, Timms, Schaffer, Skavronskaya and Little	A conceptual study	Proposed a 4-stage conceptual model of heritage preservation using immersive technologies consisting of: presentation of historical facts, contested heritage, integration of historical facts and contested heritage, and an alternate scenario.
	2018	Connel and Page	A case study	Identified 4 themes, namely place, people, network and resources, that are needed to create a dementia-friendly tourist destination.
	2018	Yu, Anaya, Miao, Lehto and Wong	In-depth semi-structured interviews	Smartphones foster a sense of family unity and individuality during family vacations, mediate families' experience at destinations, and enable recollection of experiences.
	2013	Ge, Gretzel, and Clarke	A content analysis of social media posts and responses	Developed a taxonomy of social media value co-creation opportunities in the context of DMO-initiated posts on Weibo.
	2018	Tu, Neuhofer and Viglia	A within subject experimental design	Value co-creation drives higher willingness-to-pay for hotel room through increased engagement in online hotel booking context.
Co-creating experience of underserved customers	2015	Navarro, Garzón and Norat Roig-Tierno	Analytic hierarchy process of experts perceptions	Disabled customers' relationships with staff, staff training, environment, and collaboration with other disabled customers are factors driving value co-creation.
	2018	Lin, Peng, Ren and Lin	A systematic qualitative approach including service-blueprinting, ethnography, and action research	Developed the Friendly Restaurant App to help co-create dining experiences of mobility-impaired persons by offering information on facilities accessibility, barrier-free restaurants, menu design, and taxi services.

Figure 2 Influence of Technological Advancements on the Tourism and Hospitality Sector



TECHNOLOGY DRIVEN DISRUPTIONS FOR SERVICE INDUSTRY STRUCTURES

Disruptive innovation occurs when new entrants and conditions challenge and alter industry structures and behaviour of actors. In the travel sector, these have affected relationships between stakeholders,

resulting in changes to market structures (Viglia et al., 2018). Airbnb is an example of technology-led disruption (Guttentag and Smith, 2017), where a platform enabled hosts and guests to connect and co-create value. Ultimately, Airbnb became a competitive force because it connecting customers with locals at destinations directly, in lieu of standardized hotel offerings. Travel and industry structures were thereby disrupted as customers sought cheaper, authentic and local experiences direct from citizens. The IoT is now paving the way towards smart ecosystems in tourism because of the connectivity of devices and systems that travellers can in turn customise (Gretzel et al., 2015).

Drawing on literature presented in Table 1 above, we discuss three broad areas of technological advancement that have potential to disrupt service management in the immediate future. These are VR/AR, autonomous devices or agents and location-based services including social (and social media) context.

VR and AR

VR (virtual reality) is a suite of technologies that wholly immerse the user in an artificial environment, such that sensory perceptions (somatosensory, vision, sound, and touch), are changed by the experience arising from screen-based technologies, haptic devices and exoskeletons. Through these devices, VR tricks the human mind to interpret external signals as embodied experiences of having and being in control of a body in a virtual environment (Wei et al., 2019). Beyond user experience in games, VR is disrupting micro-level management and marketing practice in service industries. VR challenges the concept of physical travel and proposes new means for imagining one's own body in a service context, irrespective of service location (Slater et al., 2009). Its application in domain of service design allows for high-fidelity prototyping of the complete customer journey (Bae and Leem, 2014). Service walkthroughs are already used to train direct providers, such as healthcare professionals, to empathize with patients and manage emergency rooms (Lee, 2017) or for hotel marketing. Tourism and hospitality organizations and destinations use VR to enable customers to experience remote sites through virtual walkarounds and pre-arrival experience of facilities. With ecommerce leaders such as Alibaba, Amazon, and Walmart laying grounds for testing VR marketplaces, VR reinvents customer decision-making processes. VR already facilitates experience storytelling because it places customers in the centre of a story (i.e., Lowe's Holoroom How To VR Experience) and empowers customers to sample services before experiencing them in real life (e.g., VR previews of Thomas Cook, Virgin Travel, Volvo, and Honda). Cultural heritage sites use VR to elicit experiences of teleportation and time travel, building on the dreams of people who have an explorer's spirit into a visit to an archaeological site (Sierra et al., 2017).

Similarly, AR (augmented reality), makes use of portable screen devices (eg., smartphones, glasses, wearables) to present layered information to users. Layers typically comprise information about the user's current environment (enabled through cameras and GPS technology) overlaid with graphical and informational content that augments the sensory experience. The technology has been popularized by PokemonGO (developed by Niantic), a computer game where players collect characters located geographically in the physical world. With increased processing speeds making real-time rich experiences possible, AR changes how service brands communicate identity and raise awareness about offers. Service brands use such interactive platforms to bring service experiences to customers' homes and boost engagement. The potential of AR to enhance the on-trip experience of tourists is more content rich than other types of displays. AR is also employed in museums, galleries and even large events to provide immersive experiences. Augmenting tourism experiences enables service management to develop interactive customer experiences, provide interactions with avatars, support interpretation and reengineer tourism experiences (Yovcheva et al., 2013). AR thereby enables added value-in-use for complex service procedures by reducing visual information retrieval time. In line with

the trend of user-centred design, AR potentially engages customers who want to use and acquire knowledge, thus hyper-personalizing content for each individual. Disruption will comprise the integration of sensor-based technologies that enable customers to access local levels of detail and whilst it is too early to say which firms will be able to add such layers, it is likely that it will be implemented by those that have competence in game-based technologies where AR is rendered through design-led interventions.

Autonomous devices or agents

Technological disruption manifests at both structural (macro) and operational (micro) levels. The emergence of autonomous devices/agents, comprising technologies embedded with sophisticated AIs, such as virtual assistants (VAs), robots, drones and connected autonomous vehicles (CAVs) is rapidly changing practices in service. Operationally, technological disruption is already influencing the restaurant sector with the adoption of robots and AI (Meek, 2018). Robots are being used not to just serve, but even make food in fast food and fast-casual settings. Spyce is a completely robot-driven fast-casual concept in Boston (USA) that has raised significant capital for growth, as is Reis and Irvy which has launched a franchise system for its automated frozen yogurt concept restaurant (Meek, 2018). Several other low-level operational initiatives use robots to flip burgers and make cocktails and are providing standardization in a traditionally human-centred service context. The resulting disruption could however be detrimental to a tourist sector that relies on local people to build unique experiences in a local service management context. AIs can further increase the scope of the service sector and substitute human labour in a range of tasks. Repetitive tasks are the first to be modelled, whilst machine learning facilitates the development of customized solutions. Human interaction in service management will be required only when extrinsic attributes and empathy are essential in the co-creation of the experience (Wei et al., 2017).

VAs (sometimes referred to as chatbots), are currently the most developed form of AI (eg., Apple's Siri, Amazon's Alexa, Microsoft's Cortana and Google Assistant) and are used by numerous firms to support customer services (Syam and Sharma, 2018) and tailor experiences to individual needs. They are widely used to service customers instantly by answering routine questions in any language and help organizations to reduce labour costs. Robot developers increasingly create realistic anthropomorphic representations to imitate natural interactions (Erica, Sophia and Kodomoroid - Stone, 2018). These may fall into an uncanny valley of creepiness (Mori, 1970) that consumers view as mere marketing gimmicks, such as the velociraptor receptionist at Japan's Hotel Okura (Lewis-Kraus, 2016). Robots can undertake repetitive tasks, support manual work and service customers at unsociable hours. Drones and CAVs have a range of applications from servicescape monitoring, data gathering, visitor guidance to remote service delivery and integrated transportation service systems within broader smart environments (Kupervasser et al., 2018). They can be used to deliver products in areas where no infrastructure is required. Such developments potentially decrease the probability of human error while freeing time for frontline service employees from repetitive tasks to humanly connect with customers.

Service industries can expect a surge of on-demand services (eg., on-demand ATM, laundry service) enabled by autonomous devices that could alleviate issues such as ground traffic congestion and road safety to improve quality of life in the most populous tourist areas. The proliferation of deep learning applications across multiple domains raises customer expectations of service. The technologies identified generate demand for more intuitive services that deliver enhanced benefits such as personalized real-time recommending, reasoning and decision-support for optimizing relationship management. Conversely, however, autonomous devices pose threats to traditional low-paid or low-skilled jobs in the service sector that may ultimately dehumanize co-created experiences, proving to be a

major disruptive force in the tourism industry. A clear example of this is the use of chatbots to replace hotel receptionists. The potential for disruption of legacy service markets by autonomous devices and agents will depend on how *economies of scope* play out in the development of services embodied in the devices and agents.

Location based services (LBS)

LBS (location based services) integrate environmental data from sensors and autonomous agents to push offers through screens and mobile technologies. Examples of LBS technologies are sensors that detect or measure physical property and records data using beacons (embedded with RFID technologies) to send signals to customers' smart devices as they approach the waypoints and advertising hoardings that recognize the characteristics of customers approaching and offer tailored services via screens located within the servicescape. With the increasing accuracy of signal processing to determine location along with facial, voice and movement recognition powered by AI, these technological advancements have potential to enhance service experience and evolve placement of advertisements and sponsored content (Giwa et al., 2018). LBS enable personalized delivery of service experience that is moment-specific i.e., contingent on the customer's geographical location. LBS track consumer activities, behavior and engagement with companies within physical contexts, thus contributing large data sets on customer behavior. Similar applications are employed in hotels to track guest location, where data is subsequently used to improve response times in delivering service and recovery. Context-based services recognize the physical environment of their users and amalgamates information with social networks to enable dynamically interactive personalized social experiences.

Tourism marketers are increasingly aware of the benefits such tools have in supporting social experiences. In general devices and technologies that allow for contextualized services threaten to disrupt any incumbents embedded in those contexts. For example, when Google Maps becomes the gateway by which tourists locate a restaurant near their hotel, local businesses will need to alter the way they provide information to customers in order to remain relevant. Likewise, when social networks provide recommendations and advice in real time, the influence of the hotel concierge or local advertising is disrupted. In these cases, networked smart devices sufficiently alter the context so that even the definition of local is altered, emphasizing the personal, social and location dimensions in the process of co-creation.

Reflecting on these three areas of technological advancement, we present an overview of relevant literature that has explored the roles of the technologies and consider how the findings highlight possible future disruptions to service experiences (Table 2) and implications for future research (Table 3). These represent three broad areas of research development within the tourism and hospitality field -

- Extra-sensory experiences, reflecting the enhanced sensory experiences possible with virtual and augmented technologies
- Hyper-personalized experiences, reflecting the merger of location and social context in service experiences
- Beyond-automated experiences, reflecting the nature of experiences beyond a process of standardization through automation of services

Table 2 How technology disrupts service experiences?

EXTRA-SENSORY EXPERIENCES			
2019	Bogicevic et al.	VR preview prompts higher elaboration of mental imagery and sense of presence, which translate into more favourable tourism brand experience, compared to 360° tour and images of the same brand.	VR allows tourism brands to stimulate tourists to "daydream" about destinations and form experiences from indirect (i.e., virtual) contact with newly developed brands that have not built their customer base in the market.
2018	Kim, Lee and Jung	Authentic VR experience drives VR attachment and visit intention toward a destination, indirectly, via cognitive and affective responses to VR. VR attachment is positively associated with visit intentions toward destinations.	Participation in tourism-related VR activities eg., seeing videos, holograms, exploring and enjoying the destination; surpasses corporeal travel and results in authentic, extra-sensory experiences that drive attachment toward the VR tourism content.
2019	Wei, Qi and Zhang	Feeling of control, participation, effectiveness, curiosity, vividness, temporal association, and enjoyment predict VR sense of presence in the context of VR theme park rides. Personal innovativeness moderates the relationship between vividness and presence. VR presence is positively associated with tourist satisfaction, revisit and recommendation intentions.	VR enables participants in hedonic tourist experiences (i.e., theme park rides) to feel in control of their experiences in mixed reality - a combination of virtual and physical experience.
2018	Tussyadiah, Wang, Jung and tom Dieck	VR presence increases enjoyment of VR experiences and results in more favourable attitudes and preference for the tourist destination. Positive attitude change is associates with higher visit intentions toward the destination.	Extra-sensory experiences powered by VR change/disrupt tourist attitudes, formed during a prior destination visit.
2018	tom Dieck, Jung and Moorhouse	Identified usability, hedonic benefits, emotional benefits, social benefits as factors that drive VR attitudes and adoption.	VR experience is disruptive because it "shows the existing world in a new light". Such extra-sensory experience drives motivational change to revisit the destination.
2018	Tussyadiah, Jung, and tom Dieck	Proposes a construct of AR technology embodiment (ownership, location, and agency) that is positively associated with enjoyment and experience in the museum context.	AR wearable technology is 'embodied', becoming an extension of one's body. It mediates experiences at a destination.
2018	tom Dieck, Jung and Rauschnabel	AR-induced four experience dimensions from Pine & Gilmore (1998) framework are positively associated with satisfaction memory and engagement intention of visitors of science festivals.	Information retrieved from AR experience is perceived as memorable and engaging.
2018	Jung, Lee, Chung and tom Dieck	Aesthetics of AR tourism heritage applications are positively associated with perceived enjoyment. The relationship between perceived enjoyment and intentions to use the AR app is stronger in high power distance cultures vs. low power distance cultures. Conversely, the relationship between social influence intentions to use the AR app is stronger in high power distance cultures.	AR technology is seen as a disruptive innovation that creates positive change in the development and design of cultural heritage tourism attractions.
HYPER-PERSONALIZES EXPERIENCES			
2016	Parise et al.	Discusses the highly personalized digital experience realized by combining location-based and immersive technologies.	'Crisis of immediacy' in relation to customers' demand for increasingly richer information in situ to overcome perceived time resource limitations of physical environment.
2018	Yu et al.	Proposes a theme park tourism system with personalized recommendation strategy based on personal preferences	Using experience and preferences of customers, identifies optimal tour routes, presents suggestions and booking information at

		and location data.	times/points when customers are most likely to be interested.
2018	Manrique-Sancho et al.	Models three types of tourist based on their map reading and spatial competencies in cities.	Service innovation for new types of tourist map based on personalized preferences, experience and familiarity with locations.
		BEYOND AUTOMATED EXPERIENCES	
2018	Tung and Au	Proposes a conceptual framework that connects robotic embodiment, human-oriented perceptions, emotions, feeling of security, with co-experience in hospitality services that integrate robotics.	Robots co-create value for consumers and disrupt norms of traditional social relationships. Engagement with robots forms relationships that go beyond human-to-human interactions.
2017	Kozlov	A method to model complexities of large datasets, producing a neuroagent - a predictive system that identifies possible problems or trends before they happen.	Predictive tool may analyse hidden relationships within big data and enable search for optimal response to emerging threats. Decision support that identifies macro-level challenges for micro-level implementation.
2017	Bowen and Whelan	Summarizes key technology trends highlighting AI/robots in a range of roles within the hospitality sector; tracking customer preferences.	Need for retaining customer relationship reflecting the nature of 'hospitality' with impacts on how to preserve privacy and appropriate levels of staff engagement with customers.
2018	Andreasson, van Oest and Lervik-Olsen	Proposes a model for optimizing decisions to automate a service and setting its price according to level of convenience to customers.	Automated service may become optimal as customers become more sensitive to service quality but only if the quality of the automation technology is sufficiently high.
2018	Breidbach et al.	Identifies three emerging themes from extant research in service: complexity, orchestration and elasticity	The nature of service system design and the processes of co-creation. Emphasis on physical and interpersonal human interaction.
2018	Wirtz et al.	Presents an overview of roles of service robots and proposes a research agenda for service researchers.	Contrasts robot and human characteristics and capabilities and differentiates the roles in service tasks that each will dominate as both complementary and competitive, context dependent.

Table 3 Summary of implications within areas of research development

Areas of research development	Technological advancements	Implications
Extra-sensory experiences	VR AR	Virtual reality could help simulate tourism experiences that could be shared with others. Tourists will grow demand for virtual, real and mixed reality sensorial experiences and co-create their reality via sensory-technology-enabled tourist attractions. Enhanced presence in virtual environments could help explain changes in tourists' attitudes toward destinations, satisfaction, sensation seeking, participation, and visitation intentions. Virtual and augmented reality could help manage the trade-offs between physical and virtual tourism where capacities, accessibility, and conservation become an issue. Sensory technologies could augment tourists' perceptual skills which transforms their understanding of reality and creates a symbiotic relationship between humans and technology.
Hyper-personalized experiences	Location-based services	Personalized offers could provide trade-offs for time constraints at destinations, while simultaneously increasing the profitability within broader tourism infrastructure (eg, restaurants, transportation). Tourism customers would learn about emerging trends in real-time. The real-time, reliable information could be used to enhance experiences.
Beyond-	Virtual assistants	Engaging with robots would help customers relate to social devices and

automated experiences	Robots Drones	establish human-AI connection. The data from these encounters would be re-used during subsequent interactions (i.e., extended customer data lifecycle management) that would shift expectations of human-AI interactions. An AI predictive system would evaluate how customers relate (eg., trust) and respond to implementations, with and without the necessary mental agility to process the macro-level challenges being addressed as well as how data is further integrated into predictive systems. Automated services should be designed to reflect customer tolerance thresholds related to device sophistication, as well as customer price/quality relationship with automated services. Service firms could face challenges to differentiate themselves and create new competencies in the technology ubiquitous market. The answer could be the focus on providing autonomous value co-creation platforms. Service robots drive positive and negative change at consumer (micro), firm (meso), and society (macro) levels.

THE EPILOGUE: EMERGING SMART DISRUPTIVE INNOVATIONS FOR SERVICE MANAGEMENT AND MARKETING

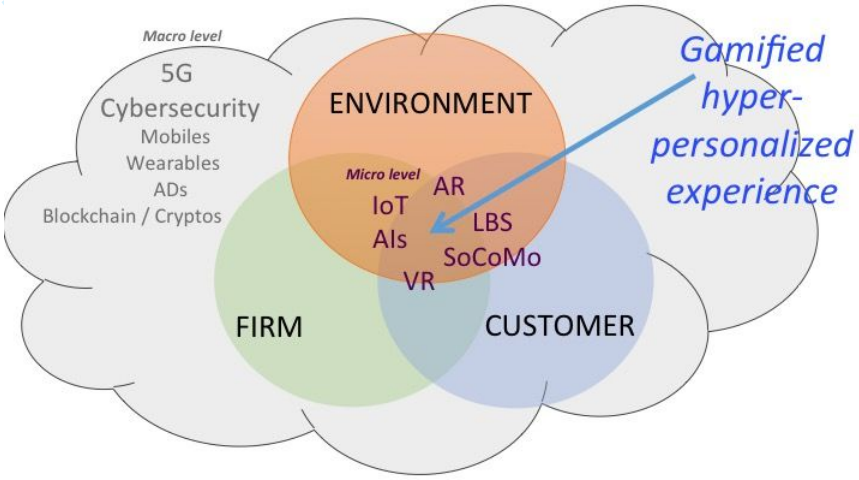
Rapid and radical technological developments create the need for extensive research in service management that examines how value is co-created between the service actors and distributed in the marketplace. At the *macro level,* governments globally invest in smart city initiatives to optimize resources, ensure sustainability and improve the quality of living through innovative technologies, a collaborative economy and collective decision-making (Saunders and Baeck, 2015). Smart cities emerge as places that require a balance between hardware and software, technology and human capital, in order to realize and guarantee a quality of life for citizens and stakeholders (Mattoni et al., 2015). A range of frameworks for strategic smart sustainable development emerge primarily for urban environments (Bibri and Krogstie, 2017) with transferable opportunities for different types of region. Smartness requires technologies, leadership, innovation and social capital supported by human capital to develop a customer-dominant logic-based ecosystem, that provides hyper-personalized and beyond-automated experiences, and achieve sustained competitive advantage and enhancement of quality of life for both residents and tourists in smart tourism destinations.

Technological advancements accelerate the ongoing tendency towards customer-firm value co-creation in many markets. In the classical manufacturing era, firms produced nearly all of the value in the products they sold. In the current environment, most of the value in the economy is created via services, rather than manufacturing, and services generally require that customers and firms co-create value. The technological advancements highlighted in this paper, such as location-based services, robots, VR, and AR put that trend into overdrive, impacting both consumers and firms (see figure 3). On the consumer side, technologies such as social media, mobile devices and IoT, reposition as powerful operant resources, closer to the end user. The leverage afforded by such resources require a new balance of power between firms and consumers as well as new regulatory frameworks (Labrecque et al., 2013). While firms may be tempted to leverage monopoly positions, especially in platform businesses, such practices may prove to be unsustainable. The use of human capital by firms requires some sort of equitable return (Cova and Dalli, 2009). Customers frequent their favorite platforms and bring their preferences and networks into relationships with other service or goods vendors. This creates a dynamic ecosystem that constantly adjusts to emerging realities and produces value for all stakeholders.

Numerous research topics can be identified at the nexus of consumer behavior and the above macro level phenomena. Smarter cities will have the same residents and tourists in them as cities have always had. What will consumers make of the commercial services they receive in these cities? How will they

react to the 'smart' component of cities and the extended customer data lifecycle management? What theories might be especially useful in predicting those reactions? It is also the case that value co-creation, as discussed, provides an interesting context for understanding consumer wants, motivations and reactions? Will consumers really want to do all of that co-creation and approve of the symbiotic relationship with technology? What motivates them to enter into co-creation exchange episodes? What are the marketing implications of the higher levels of engagement needed for co-creation? What are the implications when consumers choose not to engage? How might new regulatory frameworks associated with technological advancements moderate consumer wants, motivations and reactions?

Figure 3 Influence of Technological Advancements on the Macro and Micro Service Ecosystem



At the *micro level*, on the firm side, the relative balance between exploration and exploitation strategies increasingly depends on the firm's ecological position. Platform firms (Ramaswamy and Ozcan, 2018) such as Amazon and Google utilize both strategies. In terms of exploitation, they use their scale and unique corporate culture to enhance efficiency through beta and alpha testing, and also leverage their scale to create economies and network effects. With respect to exploration, their innovations have built-in advantages as millions of users are familiar with their products and adopt them based on the brand alone. Other global organizations such as TenCent, Alibaba, WeChat, Apple, Facebook and Microsoft have similar effects. In order to leverage the technologies outlined, however, these firms need to make changes to exploit emergent consumer demand for service innovations. The underpinning technological advancements highlighted in this paper have potential to realize service innovations which are likely to come from outsiders, start-ups and mergers, and will ultimately disrupt current market structures. By way of example, in recent years, YouTube emerged as a consequence of the demand for peer-to-peer sharing and enhanced social presence in digital world, initially blocked and controlled by original service providers, similarly Netflix to mainstream television and services such as Notonthehighstreet, eBay and others to retail. The rest of the consumer economy, the non-platform firms, are largely reduced to exploitation strategies.

With the technological advancements highlighted, it is the telecoms sector that drives the ecology through 5G connectivity and ambient intelligence. These are platform firms that define the ecology of service provision, while everyone else must refine some sort of niche within it. The ability to plug and play in those systems is paramount for the competitiveness of organizations. Many will seek to expand their market share through micro-level socio-technical service innovations that exploit co-creation between stakeholders. For example, currently, household appliance makers are forced to commit to an

IoT ecology and implement a strategy under that umbrella, whether it be held by Alexa, Google Assistant or Samsung SmartThings. In all of these cases, if a platform company sneezes, the rest of the firms nestled in that ecology catch a cold. The technological advancements present numerous research opportunities: How will firms at the platform level, like the telecoms and the others described above, balance the exploration versus exploitation mix in practice? What new models or approaches might help them in this balancing? Which new entrants can be predicted to disrupt ecologies when incumbent platforms over-rely on exploitation?

There are also many research questions at the micro level that relate to consumers' wants, motivations and reactions. Excessively exploiting current business conditions can lead to neglecting new or emerging consumer wants. Research could reveal the nature of those wants as they exist now or will exist in an environment even more crammed with autonomous devices and agents, VR and AR, and service contextualized to location and social structures. Could the overload from extra-sensory and hyper-personalized experiences have adverse effect on consumers' socialization and decision-making processes? Exploration necessarily involves experimentation; how do consumer react to being involuntary experimental subjects? Amazon customers once discovered that Amazon was experimentally exploring the price-demand curve by randomly modifying its prices. The results were not at all positive for Amazon but research could look for moderating factors that might make experimentation more palatable. Consumer research by firms is a form of exchange and it is likely that the theories we have around exchange involving reciprocity and fairness will be useful.

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