Received 25 March 2018
Revised 28 August 2018
8 November 2018
Accepted 21 November 2018

Frontline Service Technology infusion: conceptual archetypes and future research directions

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Abstract

Purpose – Smart technologies and connected objects are rapidly changing the organizational frontline. Yet, our understanding of how these technologies infuse service encounters remains limited. Therefore, the purpose of this paper is to update existing classifications of Frontline Service Technology (FST) infusion. Moreover, the authors discuss three promising smart and connected technologies – conversational agents, extended reality (XR) and blockchain technology – and their respective implications for customers, frontline employees and service organizations.

Design/methodology/approach – This paper uses a conceptual approach integrating existing work on FST infusion with artificial intelligence, robotics, XR and blockchain literature, while also building on insights gathered through expert interviews and focus group conversations with members of two service research centers.

Findings – The authors define FST and propose a set of FST infusion archetypes at the organizational frontline. Additionally, the authors develop future research directions focused on understanding how conversational agents, XR and blockchain technology will impact service.

Originality/value – This paper updates and extends existing classifications of FST, while paving the road for further work on FST infusion.

Keywords Service encounter, Blockchain, Conversational agents, Extended reality, Organizational frontline, Technology infusion

Paper type Conceptual paper

Technological advancement is profoundly impacting the very nature of the organizational frontline. The development of artificial intelligence (AI) and its swift spread through various connected smart objects, such as wearables, voice-controlled digital assistants and humanoid robots, is fundamentally changing the ways in which service is delivered and experienced by its two key involved actors – customers and frontline employees (FLEs) (Bolton *et al.*, 2018; Larivière *et al.*, 2017). While service encounters used to be a "game of people" between customers and FLEs (Bowen, 2016), Frontline Service Technology (FST)

This project emerged from the Let's Talk About Service (LTAS 2015) workshop at Ghent University, Belgium. The authors would thus like to thank the organizers Bart Larivière, Wafa Hammedi and Annouk Lievens. In addition, the authors would like to thank the organizers and participants of the 2018 Organizational Frontlines Research Symposium for their feedback on an earlier version of this manuscript.

Journal of Service Management
Vol. 30 No. 1, 2019
pp. 156-183

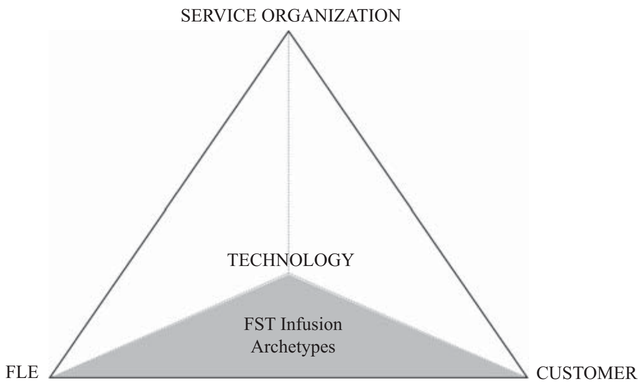
1757-5818
DOI 10.1108/JOSM-03-2018-0082

infusion is now omnipresent and altering customer–FLE interactions as we know them (van Doorn *et al.*, 2017; Giebelhausen *et al.*, 2014).

Parasuraman (1996) was among the first to formalize technology's role in service delivery, introducing it as a key dimension of the service pyramid model together with customers, FLEs and the service organization (see Figure 1). While this has led to a vast amount of FST research, a large majority focuses on non-smart technologies such as ATMs and self-checkouts (Huang and Rust, 2018; Verhoef *et al.*, 2017). Novak and Hoffman (2018), however, point out that the increasingly smart nature of technology and the rise of connected objects requires an expanded thinking about technology's relationship with other entities. Smart technologies and connected objects not only alter common technology-enabled encounters (e.g. voice-based interfaces and robots are rapidly becoming standard for self-service applications), but also give rise to entirely new encounter forms (e.g. machine-to-machine (M2M) service encounters in which FLEs and customers become obsolete). As such, there is a need to evaluate how smart and connected technologies fit into the service pyramid and to assess their impact on the pyramid's other entities.

To this end, we first introduce an updated typology of FST infusion archetypes organized around technology's augmenting and substituting roles for service delivery (Larivière *et al.*, 2017; Marinova *et al.*, 2017). The primary focus of these archetypes lies on the "customer–FLE–technology" triad as it is key to any service organization (Larivière *et al.*, 2017), and has been at the center of much organizational frontline research (Singh *et al.*, 2017). In this effort, we update prior archetypes that date back 14 years ago (e.g. Froehle and Roth, 2004) and expand several technology-specific classification endeavors (e.g. Meuter *et al.*, 2000; Schumann *et al.*, 2012). Our expanded set of archetypes not only offers a basis to organize current and future literature but also enables researchers and managers to discuss, examine and devise strategies for various (smart) technology-based service delivery options (as called for by Rafaeli *et al.*, 2017; Yadav and Pavlou, 2014).

Second, building on industry reports, expert interviews and focus group conversations with members of two global service research centers, we select three understudied technologies that are relevant to all identified archetypes – conversational agents, extended reality (XR) and blockchain technology. We consider their integration within the service pyramid and identify research directions related to each technology's design and their respective implications for customers, FLEs and service organizations. As such, we hope to offer a platform to advance the next generation of FST knowledge development.



Sources: Adapted from Parasuraman (1996, 2000)

Figure 1.
The service pyramid

Frontline Service Technology

Organizational frontlines are of key importance to any service organization as they form the boundaries between the company, its customers and other stakeholders (Singh *et al.*, 2017). Traditionally, the significant role of FLEs has been emphasized. In "high-touch, low-tech" encounters, FLEs represent the key factor driving successful service encounters through building pleasing and rewarding social relations (Giebelhausen *et al.*, 2014). Today, however, the service encounter is increasingly infused with technology aimed at reducing the cost of hiring, managing and maintaining FLEs, while also offering better, more personalized service through big data insights (Rust and Huang, 2014). In the following section, we define FST and provide an overview of existing FST infusion classifications.

Defining Frontline Service Technology

FST infusion, considered by van Doorn *et al.* (2017) as "the incorporation by service organizations of technological elements into the customers' frontline experience" (p. 43), is now omnipresent and facilitating technology-enabled human-to-human, human-to-technology and technology-to-technology service encounters (Larivière *et al.*, 2017). Examples are varied and range from basic technologies such as ATMs to advanced humanoid robots supporting service delivery (Mende *et al.*, 2017). Building on Huang and Rust (2017) and Yadav and Pavlou (2014), we define FST as "any combination of hardware, software, information, and/or networks that supports the co-creation of value between a service provider and customer at the organizational frontline." The organizational frontline is reflective of discrete interactions or touchpoints between a service provider and its customers (Singh *et al.*, 2017).

Today, FST mainly functions as a resource facilitating value creation in the exchange process between a customer and a service provider – e.g., Apple Pay simplifies and fastens payment processes (Akaka and Vargo, 2014). Smart and connected technologies, however, may take on an actor role in the value creation process with the ability to act (agency) by themselves (autonomy) without external intervention (authority) (Novak and Hoffman, 2018) – e.g., Nest's self-regulating thermostat may control and adjust heating systems without external intervention.

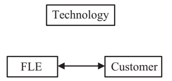
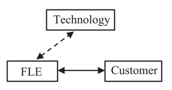
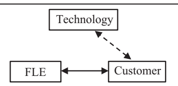
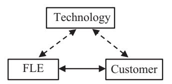
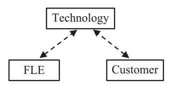
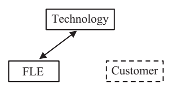
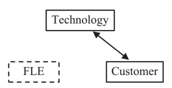
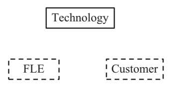
Frontline Service Technology infusion – existing classifications

Previous research has sought to classify the various configurations of FST infusion. An initial classification is presented by Dabholkar (1994). Her classification scheme categorizes technology-based services using three criteria, considering who (i.e. a FLE using technology or technology itself), where (i.e. at the service site or at the customer's home/workplace) and how (i.e. physical proximity or distance between service provider and customer) a service is delivered. Meuter *et al.* (2000) zoomed-in on self-service technology (SST) and distinguished between multiple SST types based upon their purpose (i.e. customer service, transaction and self-help), and technological interface (i.e. interactive telephone, internet, kiosk and video/CD). Cunningham *et al.* (2008) similarly limited their classification to SST and categorize various SST options depending on their level of separability (i.e. the extent to which a customer can make a distinction between a SST and its outcome) and customization (i.e. the extent to which a SST can be adapted to an individual customer). Froehle and Roth (2004) offered the broadest classification to date and consider how technology is important for both face-to-face and face-to-screen encounters. Specifically, they introduced five conceptual service encounter archetypes: technology-free customer contact; technology-assisted customer contact (i.e. technology in support of the FLE); technology-facilitated customer contact (i.e. technology in support of FLE and customer); technology-mediated customer contact (i.e. technology connecting FLE and customer); and technology-generated customer contact (i.e. SST). Bolton and Saxena-Iyer (2009) classified service encounters based on the level of customer participation (i.e. high vs low) and the extent to which a service is technology-enabled (i.e. high vs low). Finally, Schumann *et al.* (2012) developed a typology of technology-mediated services, distinguishing between SSTs, remote services and interactive services that can either be provider or customer based depending on the location where the technology is accessible.

While each of these classifications is informative, they largely overlook recent technological advancements and consequently do not account for new ways of FST infusion. Moreover, many of previous classifications focus on one particular type of FST infusion with a dominant emphasis on SST-driven encounters (e.g. Meuter *et al.*, 2000). Therefore, the next section of this paper seeks to introduce an updated classification of FST infusion.

Frontline Service Technology infusion archetypes – an update

Building on recent work by Marinova *et al.* (2017) and Larivière *et al.* (2017), we update existing FST infusion classifications[1] based upon their role in the service encounter: augmentation and substitution (see Table I for a summary). For the sake of comprehensiveness, we acknowledge service encounters in which technology is

		Archetype	Visualization	Examples	Example literature
NO FST	A	Technology-free encounter		• traditional ticket counter • manual therapy	• Solomon *et al.* (1985) • Bitner *et al.* (1990)
AUGMENTING FST	B	Customer/technology-assisted FLE encounter		Existing technologies • electronic order taking • computer-assisted check-in Emerging smart and connected technologies • physician smart glasses (e.g. Augmedix) • emotion-recognition software (e.g. Affectiva)	• Ahearne *et al.* (2008) • Wu *et al.* (2015)
	C	Technology-assisted customer/FLE encounter		Existing technologies • price-comparison mobile applications (e.g. ShopSavvy) Emerging smart and connected technologies • image recognition software (e.g. Google Lens)	• Rapp *et al.* (2015) • Spaid and Flint, (2014)
	D	Customer/FLE technology-facilitated encounter		Existing technologies • assisted self-check-in • co-design software (e.g. IKEA) Emerging smart and connected technologies • augmented reality interaction (e.g. Lowe's hologram experience) • real-time translation software (e.g. Baidu's pocket translator)	• Roy Chowdhury *et al.* (2014) • Giebelhausen *et al.* (2014)
	E	Customer/FLE technology-mediated encounter		Existing technologies • phone-assisted booking • email complaint handling Emerging smart and connected technologies • long-distance robotic surgery • virtual reality meetings	• Froehle and Roth, (2004) • Froehle, (2006)
SUBSTITUTING FST	F	Technology-substituted customer/FLE encounter		Existing technologies • remote monitoring and repair services (e.g. Siemens Wind Power) Emerging smart and connected technologies • smart locks (e.g. Amazon Key) • virtual assistants (e.g. Google Duplex)	• Paluch, (2014) • Paluch and Blut, (2013)
	G	Customer/FLE-substituted FLE encounter		Existing technologies • ATMs • online banking Emerging smart and connected technologies • autonomous taxis • humanoid service robots • virtual assistants (e.g. Siri, Alexa, etc.)	• Čaić *et al.* (2018) • Meuter *et al.* (2000) • Van Doorn *et al.* (2017)
	H	Full technology encounter		Existing technologies • M2M automated utility billing • automated toll stations (e.g. SunPass Florida) • automation applets (e.g., IFTTT) Emerging smart and connected technologies • automated shopping services • self-filling autonomous vehicles	• Hoffman and Novak, (2017) • Novak and Hoffman, (2018) • Ng and Wakenshaw, (2017) • Verhoef *et al.* (2017)

Notes: ←→ Direct interaction; ←-→ direct interaction augmented by technology; [dashed box] substituted by technology

Table I.
FST infusion archetypes

absent – we label them technology-free encounters (Archetype A – see Table I). These encounters encompass direct physical interactions taking place between FLEs and customers where technology does not play a role in the service provision. Although they still exist, pure technology-free encounters are becoming increasingly rare.

Technology as a human augmentation force

Human augmentation represents one of FST's key roles (Larivière *et al.*, 2017). The augmenting role of FST involves assisting and complementing different human actors – customers and/or FLEs – to perform their parts better and achieve their goals in the service encounter (Marinova *et al.*, 2017). More precisely, technology may enhance human thinking, analysis and behavior and thus work in tandem with human actors to boost their ability to interact with other human actors (Hilken *et al.*, 2017). In essence, we identify four distinct ways in which technology may act as an augmenting force to customers and/or FLEs in the service encounter.

A customer/technology-assisted FLE encounter (Archetype B – see Table I) entails a service encounter in which the FLE is augmented by technology to interact with customers in more meaningful ways while being in direct physical presence – be it faster, cheaper, more convenient and/or personalized (Ahearne *et al.*, 2008; Rust and Huang, 2014). Traditional examples include electronic order taking in restaurants, airline and hotel check-ins where a FLE interacts with a computer terminal. However, smart technologies are enhancing this archetype significantly. Companies like Augmedix provide smart glass technologies that assist physicians in collecting, updating and recalling patient data in real-time, while emotion-recognition applications (e.g. affectiva.com) may help FLEs display the appropriate emotions when dealing with customers (Huang and Rust, 2018).

A technology-assisted customer/FLE encounter (Archetype C – see Table I) entails service encounters in which the customer is augmented by technology while being in direct physical presence with FLEs. This encounter is becoming increasingly relevant as many customers have one or multiple technological devices (e.g. smartphone, smartwatch, etc.) on them at all times. In a state of permanent connectivity, information sources other than the FLE are at real-time disposal to guide service interactions (Grewal *et al.*, 2018). Shopsavvy, for instance, allows customers to scan products in order to find the best online and local store deals. A recent Deloitte (2016) report indicates that over 90 percent of smartphone owners regularly use their device during shopping and while interacting with other people. Correspondingly, we observe the rise of dedicated customer augmentation applications. Google, for instance, recently launched Google Lens, which allows any user to scan objects to obtain relevant background information in real-time. This application offers ample opportunities for customers to better understand certain aspects of the service encounter, such as obtaining detailed product information in a retail context. While this may strengthen customer–FLE interactions (Spaid and Flint, 2014), it may also negatively impact FLEs if they feel threatened in their position (Rapp *et al.*, 2015).

A customer/FLE technology-facilitated encounter (Archetype D – see Table I) entails customer–FLE real-time encounters in which both customers and FLEs have access to the same augmenting technology while being in direct physical presence and contact. Traditional examples include assisted self-check-ins at the airport and IKEA's kitchen co-design approach. Again, smart technologies are updating this archetype. Lowe's, for instance, introduced a new approach to its kitchen co-design efforts labeled as Lowe's Hologram Experience. Customers get to wear a Microsoft HoloLens which adds a virtual layer to a model kitchen in-store, allowing them to see and adapt kitchen layouts in real-time with the help of a FLE. Another example is Baidu's launch of a pocket-sized translator able to translate spoken sentences in English into Mandarin and back again in real-time. Technology augmentation here facilitates value creation by enhancing the resource exchange process resulting in expanded and enhanced interaction capabilities and co-created value for both parties.

Finally, a customer/FLE technology-mediated encounter (Archetype E – see Table I) entails FLE–customer encounters where both parties are not physically co-located and technology enables their interaction (Froehle and Roth, 2004). Common examples relate to service encounters through phone (e.g. phone-assisted bookings), e-mail (e.g. complaint handling via e-mail), instant messaging (e.g. WhatsApp for business), chat (e.g. LiveChat) and more recently hologram communications. Currently, Internet of Things (IoT) technologies provide novel opportunities within these archetypes. In healthcare, for instance, surgeons can now operate by controlling surgical robots from a distance (Schumann *et al.*, 2012). Overall, the value of technology augmentation in this encounter lies in connecting geographically separated parties for service delivery up to a level in which the perceived distance may become obsolete, hence providing higher convenience and cost-savings for both FLEs and customers.

Technology as a human substitution force

Next to augmentation, technology's goal might be to substitute customers and/or FLEs. More precisely, the substituting role of FST reflects technology's purpose to replace and automate humans' active input in the service encounter (Marinova *et al.*, 2017). In other words, as technology substitutes a human actor, the latter no longer takes an active role in the service encounter and is "represented" by a technology-driven counterpart (Larivière *et al.*, 2017). While human substitution by FSTs has been around for a long time – ATMs and check-in kiosks as prime examples – its presence is expected to intensify in the coming years (Huang and Rust, 2018). IBM (2017) predicted that by 2020, 85 percent of customer–firm interactions will be conducted via computerized technologies, without human involvement. Concretely, we identify three distinct archetypes where technology may substitute customers and/or FLEs.

A technology-substituted customer/FLE encounter (Archetype F – see Table I) involves a service encounter where customers are substituted by technology – which either autonomously makes decisions on behalf of the customer or is subject to a set of pre-defined customer preferences (Verhoef *et al.*, 2017). In other words, FLEs[2] interact with a technological counterpart that replaces the customer. In most instances, this archetype links to remote services where the service provider can actively access a service object over long distances, and where the service object automatically interacts with the service provider without necessarily involving the customer (Schumann *et al.*, 2012). Examples of this archetype are often found in B2B service settings like IT and engineering. Siemens, for instance, has developed software by which they can remotely monitor and in many cases fix technical issues that arise with customers' off-shore wind turbines. This archetype, however, is also becoming increasingly prevalent in B2C settings due to the adoption of consumer IoT applications (Verhoef *et al.*, 2017). Amazon Key is a recently launched in-home and in-car delivery service allowing pre-authorized Amazon shippers to gain access to one's home or car for package deliveries through a smart lock. Google Duplex can make calls on behalf of its users and engage in services like scheduling an appointment or asking simple inquiries. The value of technology substitution lies in "relieving" the customer from any effort, offering enhanced service convenience not bounded by a specific location (Berry *et al.*, 2002; Schumann *et al.*, 2012).

The customer/technology-substituted FLE encounter (Archetype G – see Table I) is perhaps the most prevalent substitution archetype, with FLEs being replaced by technology. Hence, the customer interacts with a technological interface void of direct human interaction (Meuter *et al.*, 2000). Examples under the SST label are numerous and involve self-service kiosks, ATMs, online banking and online retail ordering. The variety of examples under this archetype is expected to grow exponentially with advances in AI. Customers are starting to use services provided by autonomous vehicles, humanoid service robots and voice-based assistants. Overall, the value of technology substitution can be found in cost-savings for the firm (Kimes and Collier, 2015), and higher flexibility (Meuter *et al.*, 2000), convenience (Ding *et al.*, 2007) and satisfaction resulting from active participation (Dong *et al.*, 2015) for the customer.

Finally, a full technology encounter (Archetype H – see Table I) entails a situation in which both FLEs and customers are replaced by technology – with potentially varying levels of technology autonomy (Novak and Hoffman, 2018). The active involvement of FLEs and customers is no longer needed for service to take place. While relatively new and limited in scope, advances in IoT are pushing the expansion of this service archetype – often labeled as M2M service interactions (van Doorn *et al.*, 2017). SunPass, Florida's prepaid toll program, allows customers to attach a transponder to the inside of their car, which interacts with sensors in toll lanes as they drive through it. The toll amount that is due is automatically deducted from a prepaid account. If This Then That (IFTTT) applets allow users to automate tasks, such as turning on porch lights pending on a positive signal that pizza delivery is on its way (Hoffman and Novak, 2017). As IoT applications continue expanding, this archetype will gain importance and include services like IoT tags monitoring product usage for automatic order refills/replacements and autonomous vehicles that self-fill and self-update. The service process runs autonomously, and no action from a FLE or customer is needed. The value of technology substitution lies in cost-savings for the service provider while offering higher service convenience and speed for the customer (Berry *et al.*, 2002).

Taken together, these FST infusion archetypes reflect the various ways in which technology may directly impact the service encounter. Not only can they help organize existing and future literature, they may also be helpful for managers to deliberate how technology may be integrated in various service settings (Rafaeli *et al.*, 2017; Yadav and Pavlou, 2014)[3]. Moreover, our update highlights the importance of relatively new archetypes – C, F, H – in a smart and connected service landscape.

It is important to note that a single technology may play a key role in various archetypes. Take the example of an alarm system. Here, IoT sensors are typically in continuous contact with a local office transmitting situational data (Archetype H). If an attempted burglary is detected, however, that same system will alert residents through a message (Archetype G) and contact security guards for a check (Archetype F). From this example, it is also clear that a total service experience is typically comprised of a combination of various archetypes. Their connection is of critical importance to the customer experience (Homburg *et al.*, 2017), pointing to the managerial importance of designing suitable archetype combinations for service delivery.

Frontline Service Technology infusion – looking forward to a smart and connected service world

While great strides have been made to understand the role of technology at the organizational frontline, many things remain unknown (Ostrom *et al.*, 2015; Singh *et al.*, 2017). To date, various authors have posited generic technology-related future research directions (e.g. van Doorn *et al.*, 2017; Kannan and Li, 2017; Larivière *et al.*, 2017) or zoomed-in on a particular technology like robotics (e.g. Wirtz *et al.*, 2018), smart devices and IoT (e.g. Ng and Wakenshaw, 2017; Verhoef *et al.*, 2017; Wünderlich *et al.*, 2015) and mobile technologies (Shankar *et al.*, 2016). However, various new smart technologies and connected objects have appeared that are predicted to have a major impact on the organizational frontline and the service area in general. Based upon recent technology prediction reports (e.g. Deloitte, 2018; Gartner, 2017), input from various service scholars and two focus group discussions with members of service research centers[4], this section of the paper seeks to understand how three such technologies – conversational agents, XR and blockchain systems – infuse the service pyramid and what new questions arise from their integration. We organize these questions around the four dimensions of the service pyramid (see Figure 1). Interestingly, all three technologies may impact all archetypes identified and hence cover a broad range of service interactions. While conversational agents, XR and blockchain systems are widely discussed in practice, they lack an in-depth discussion in service research. A summary of the research directions can be found in Table II.

Research Area 1: conversational agents

Conversational agents are rapidly becoming one of the most promising technologies in the service industry (Kumar *et al.*, 2016). A conversational agent can be considered as a physical or virtual autonomous technological entity capable of reactive and proactive behavior in its environment (Holz *et al.*, 2009), with the ability to accept natural language as input and generate natural language as output in order to engage in a social conversation with its users (Griol *et al.*, 2013). It comes in various forms that can be placed along a reality–virtuality continuum (cf. Holz *et al.*, 2009 – see Figure 2). At the reality end of the continuum are physical conversational agents – often referred to as social robots (Čaić *et al.*, 2018) – that are tangibly present in the environment and able to set-up conversations with their users by means of facial and voice recognition software. One such example is the robot Nao (softbankrobotics.com) that is used by Japan's largest financial institution, MUGF Bank, to answer standard inquiries in three different languages. At the virtuality end are disembodied conversational agents – often referred to as voice-based assistants and/or chatbots – which are purely voice- and/or text-driven agents lacking bodily appearance (Araujo, 2018). Examples are various, including Apple's Siri, Amazon's Alexa and Alibaba's AliGenie. Moving away from the edges of the continuum are embodied conversational agents which, in contrast to disembodied conversational agents, are virtual characters that have a bodily appearance (human or non-human) allowing them to dialogue with users by using not only speech and/or text but also other non-verbal capabilities such as emotional display, gesture and glance (Mimoun and Poncin, 2015). The US military's Sergeant Star, for instance, acts as a virtual human guide on its website to answer queries on army careers, training and education. Finally, mixed reality conversational agents combine physical and virtual elements when interacting with users (Holz *et al.*, 2011). One such example is Pepper (softbankrobotics.com), previously used by Pizza Hut to take orders from customers in designated restaurants. Its interaction is based upon robotic speech in combination with virtual content that appears on an accompanying tablet.

Conversational agents are relevant to all of the identified archetypes (with the exception of Type A – see Table I). In what follows, we consider research directions related to conversational agent design, and their respective implications for customers, FLEs and the service organization.

Conversational agent design considerations. Conversational agent design reflects its appearance, behavior and interaction mode (Fink, 2012). In terms of appearance, a first topic of interest relates to whether or not an agent profits from having a physical/virtual embodiment? Initial academic findings demonstrate mixed results (Krämer *et al.*, 2009), and have not yet established the conditions under which agent embodiment (dis)favorably impacts customers and/or FLEs. When agent embodiment is considered, multiple forms may appear. These can be characterized into one of four groups: anthropomorphic (human-like), zoomorphic (animal-like), caricatured (cartoon-like) and functional (Fong *et al.*, 2003). A critical decision for any service provider relates to which embodiment fits with its customer base and the agent's role in the service process. What levels of customer and/or FLE expectations (e.g. perceived agent intelligence) are raised by different forms? And to what extent do different forms impact levels of agent trust, empathy and/or anxiety? While research seems to suggest human-like forms perform best in facilitating social interactions between agents and humans (Li, 2015), some evidence shows that other forms might work better in specific cases. For instance, Coeckelbergh *et al.* (2016) suggest that animal-like agents may be preferred above human-like alternatives when interacting with children.

Topic	Research questions
Conversational agents	*Design considerations* How does agent embodiment (and its multiple forms) impact customer/FLE perceptions (e.g. agent acceptance, level of expectations, trust, etc.)? What is the impact of additional features such as agent clothing, gender, and implied culture? What is the optimal level of agent anthropomorphism? Does this vary across individuals and cultures? How do agent behaviors (e.g. emotional display, gestures, gaze and movement) influence customer/FLE perceptions? How do differing interaction modes (text, voice, gesture, movement, touch) impact customer/FLE perceptions?
	Customer considerations What factors drive customer preference to interact with conversational agents vs FLEs? At what points of the service journey are conversational agents most welcomed by customers? Are some customer segments willing to pay extra for FLE-contact over conversational agents? In what situations? To what extent are service providers (better) able to build customer relationships? Under what conditions do customers show a preference for algorithmic vs autonomous choices?
	FLE considerations How do FLE roles change following the introduction of conversational agents at the organizational frontline? To what extent do FLE-assisted conversational agents outperform fully automated agents? Under what conditions does conversational agent-FLE collaboration generate positive/negative outcomes? How can FLE–conversational collaboration be optimized? What training and resources are needed to foster such collaboration?
	Service organization considerations What tasks/services allow for the implementation of conversational agents? Can conversational agents take over the entire service journey? What (new) metrics are needed to evaluate conversational agent performance? How can conversational agents contribute to a cost-effective service excellence strategy? How can managers harness the frontline innovation potential of conversational agents? What is the importance of control over the organizational frontline? What is the impact of third-party agents on the organizational frontline? Does service branding still matter? What is the importance of machine-to-machine marketing?
Extended reality	*Design considerations* How do dedicated vs non-dedicated XR platforms impact the customer/FLE experience? How do various hardware options (e.g. use of HMD, smartphone, etc.) impact the customer/FLE experience? Does active participation in an XR environment enhance the customer/FLE experience (e.g. sense of telepresence)? How do behavioral incongruencies impact FLE/customer perceptions (e.g. intuitivism) of XR applications? What is the impact of various XR interfaces (e.g. auditory, visual, haptic, olfactory and gustatory) and their combinations on the customer/FLE experience? In what situations do XR frontlines lead to sensory overload?
	Customer considerations What factors drive customer adoption of XR? How do individual differences impact XR perceptions (e.g. acceptance, level of expectations, etc.)?

Table II.
FST infusion future research directions

(*continued*)

Topic	Research questions
	To what extent does XR complement and/or substitute existing service channels?
	In what ways can XR enhance customer outcomes (e.g. decision confidence)?
	To what extent does XR worn by FLEs and/or other customers dehumanize the organizational frontline?
	Does the use of XR tools in the service environment raise privacy concerns? When do customers wish to avoid XR-dominant service settings?
	To what extent are customers willing to share their personal data with XR tools?
	FLE considerations
	Does XR-enabled training better prepare FLEs to deal with customers?
	Will the rise of XR training provide a boost to corporate FLE training in general?
	To what extent can XR applications enhance FLE performance and productivity?
	Does XR enhance FLE motivation?
	Does customer usage of XR tools hinder FLEs and impact their well-being?
	Service organization considerations
	How may AR, VR and MR contribute differently to the service journey? What tasks/services are most prone to XR usage?
	When and how may XR complement and/or substitute existing service channels?
	What services and customer segments are most prone to XR substitution?
	To what extent does XR enable the acquisition of new (vulnerable) customer segments?
Blockchain	*Design considerations*
	What are current best practices in relation to blockchain properties (i.e. data access, type of permissioning, consensus mechanism, modularity, scalability, interoperability, level of centralization, anonymity)?
	How do managers need to trade-off various blockchain properties? What best combinations exist?
	Customer considerations
	To what extent do customers demonstrate higher levels of trust toward blockchain-enabled organizational frontlines?
	Do customers want their behavior/interactions to be logged and stored permanently?
	Does the removal of traditional third-party service intermediaries lead to an increase or decrease of customer trust levels in the service organization?
	Does blockchain-enabled product/service transparency impact customer trust, willingness-to-pay, product/service quality perceptions?
	Under what conditions (e.g. high vs low brand familiarity) does blockchain impact customer outcomes most?
	FLE considerations
	To what extent do blockchain systems enhance FLE tasks such as complaint handling?
	How can blockchain technology aid FLEs to deal with dysfunctional customer behaviors?
	What is the impact of blockchain technology on FLE performance? Does it diminish potential FLE sabotaging behavior?
	Can blockchain technology be used as a positive force for employee monitoring?
	Service organization considerations
	Does the acceptance of cryptocurrency attract novel customer segments?
	How big are the business and financial risks related to cryptocurrency exchanges?
	What services are prone to automation via smart contracts? How far does the customer/FLE substitution potential of smart contracts reach?
	To what extent can smart contracts enhance service quality levels (e.g. convenience, speed, etc.)?
	Will smart contracts enable the breakthrough of IoT services?
	To what extent can blockchain technology support the growth of sharing services? How are traditional sharing platforms threatened by the decentralization aspects of blockchain?

Table II.

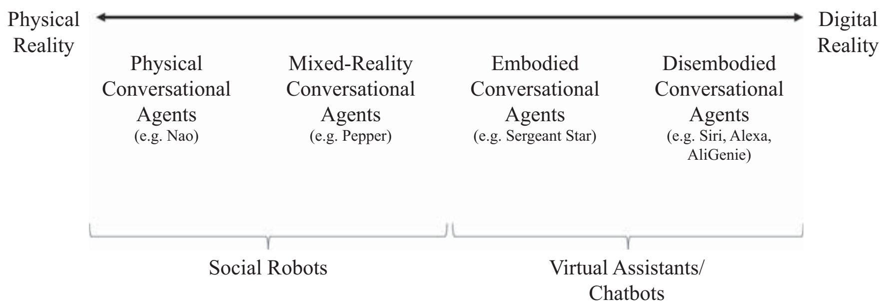


Figure 2.
Conversational agents

While various forms are possible, there is a dominant trend to anthropomorphize conversational agents (Mathur and Reichling, 2016). This idea builds on the premise that customers and FLEs can more easily relate to human-like forms (Złotowski *et al.*, 2015). There is, however, ongoing debate as to what constitutes the optimal level of human-like appearance. The "uncanny valley" effect suggests that conversational agents may reach a point where their resemblance to humans is high but not quite perfect, and those imperfections make people uncomfortable (Li, 2015; Mathur and Reichling, 2016). Researchers may examine the impact of the anthropomorphic level (low vs middle vs high) on customer/FLE–agent perceptions (e.g. competence, warmth and attractiveness – van Doorn *et al.*, 2017) and acceptance (Wirtz *et al.*, 2018), controlling for cultural and individual differences (Złotowski *et al.*, 2015). Additionally, research could look at the impact of agent implied gender (today many agents are female), culture, physical appearance, clothing and other relevant organizational frontline features on conversational agent evaluations.

Next to appearance, agents' behavior during an interaction is a critical design factor. As Holz *et al.* (2009) indicated, "effective human-agent interaction is by the same token, based on the social relationship and the mutual understanding between user and agent, improving predictability and trust between the two" (p. 85). While great strides still need to be made, conversational agents are increasingly capable of understanding, mimicking and self-generating contextualized verbal and non-verbal cues (Holz *et al.*, 2009). The more agents appear to have human-like mental capacities and behaviors, the more customers and FLEs can build rapport (Wilson, Lee, Saechao, Hershenson, Scheutz and Tickle-Degnen, 2017; Wilson *et al.* 2017a, b). To this end, more research is needed to investigate how various agent behaviors impact customer/FLE evaluations and rapport-building intentions. So far, conversational agent behaviors have been manipulated in a variety of ways, including emotional display (Cameron *et al.*, 2018), body language (Beck *et al.*, 2010), personality exhibition (Callejas *et al.*, 2014), gaze (Admoni and Scassellati, 2017), gestures and movement (Castro-González *et al.*, 2016), use of humor (Tay *et al.*, 2016) and others. While the impact of these factors has generally been considered in isolation (Fong *et al.*, 2003), more research is needed considering how these various elements may be combined and how distinct combinations impact customer/FLE outcomes like trust, satisfaction and acceptance of conversational agents (Wirtz *et al.*, 2018).

Finally, agent interaction mode is a third important design consideration and involves the way in which customers/FLEs may interact with conversational agents (Jaimes and Sebe, 2007). The most common modes include text, voice, gesture, movement and touch-based agent interactions (Karray *et al.*, 2008). Accordingly, it is important to assess how different interaction modes impact customer/FLE perceptions and behavior and what factors (e.g. location, device type and activity) drive mode preference. Krämer *et al.* (2009), for instance, showed that voice-based interactions preference increases when dealing with service recovery, whereas text-based preference drops.

Conversational agent and customer considerations. Research is needed examining customer preferences for the various types of conversational agents and their trade-off with human intervention. For instance, an industry report by Buvat *et al.* (2018) shows that already more than 40 percent of consumers would prefer a voice assistant (i.e. voice-mode) over a website/app (i.e. touch-mode) and a human service representative. The suggested reasons are manifold, including heightened convenience, feelings of personalization, ability to do things hands-free, avoiding talking with a service representative and a stronger sense of natural interaction. Researchers could investigate when and why some customer segments prefer indirect communication (i.e. voice assistants, chat) above direct human interaction and vice versa. De Keyser *et al.* (2015), for instance, suggested that online-prone customers may actually prefer human interaction to deal with service failures and/or follow-up requests. Research on conversational agents might, therefore, benefit from integrating existing multichannel literature. What factors (e.g. ease-of-use, effort, enjoyment, risk and perceived benefits) impact conversational agent choice? When do customers prefer traditional interaction channels (e.g. face to face, phone and e-mail) and/or other digital channels (e.g. website, mobile applications) over conversational agents? How do individual differences (e.g. age, gender, cultural values, previous experiences and technology readiness) impact this choice? Do customers prefer to keep interacting with conversational agents across the entire service process, or should organizations steer customers to other (human) channels at specific points in the service process? Are customers willing to pay extra for human service?

While conversational agents are considered as ideal channels to deal with simple queries, they become increasingly able to deal with complex problems and push (additional) sales. This has led to the emergence of conversational commerce, in which conversational agents drive sales (Tuzovic and Paluch, 2018). Retailers such as Walmart, Target, Costco and Walgreens, for instance, have implemented voice-based shopping opportunities through Google Express. Research is needed to help guide managers in understanding the impact of conversational commerce on the service journey. What are customers looking for in terms of interaction? Do they want to engage in quick or broad conversations? How far should the conversational capabilities of agents reach (e.g. information provision, ordering and payment capabilities, small talk)? To what extent are service providers (better) able to build deep relationships with their customers through conversational agents? What is the impact of AI-driven conversational layers on customer outcomes (e.g. churn, loyalty and cross-/up-selling)? What is the optimal ratio of customer–FLE/customer–conversational agent interactions along the service journey?

Finally, questions arise regarding the extent to which customers put faith in algorithmic suggestions and decisions. Voice assistants such as Amazon's Alexa or Google's Home learn customer preferences over time and are increasingly able to predict customer needs. This, in turn, creates a paradox. Algorithmic predictions and suggestions offer the opportunity to reduce or even eliminate search costs and to propose offerings that may correspond better to customer preferences than if they themselves had made the choice (André *et al.*, 2018). Nevertheless, this may negatively impact customers' sense of decision autonomy and therefore raise customer reactance to agent suggestions. Research is needed to understand the conditions under which customers show a preference for either algorithmic or autonomous choices, considering various contextual (e.g. implications of choice for one's identity), cultural (e.g. individualistic vs collectivist orientation) and individual (e.g. self-esteem) differences (André *et al.*, 2018), while also looking into managerial policies that may encourage customers' acceptance of algorithmic suggestions (e.g. Facebook users can now find more information on why they are shown certain advertisements in order to raise algorithm transparency).

Conversational agent and FLE considerations. The growing prevalence of conversational agents points to several FLE considerations. Given that a majority of customer interactions might be handled without the need for a human agent, it is clear that FLEs will need to take on different roles in the future. Bowen (2016) and Larivière *et al.* (2017) identify four such roles, seeing FLEs as an enabler, innovator, coordinator and differentiator. While each of these roles will be important, more research is needed to understand which role will be dominant, how service organizations can prepare FLEs to take on these various responsibilities and how FLE performance metrics need to be adapted to fit with these new roles.

While much work focuses on the "disappearance" of FLEs (e.g. Frey and Osborne, 2017), future work may expand our knowledge on the FLE–technology interplay. Practitioner reports increasingly acknowledge that the highest performance gains appear when humans and machines work together, rather than when machines fully substitute humans (Shook and Knickrehm, 2018). Humans may assist conversational agents in multiple ways. This includes training (i.e. teaching agents to perform the work they need to do), explaining (i.e. clarifying agents outcomes to other human actors to enhance transparency) and sustaining (i.e. ensuring agents function properly, safely and responsibly) conversational agents (Wilson *et al.* 2017a, b). Researchers need to explore how employees can take on these functions, and to what extent human-assisted agents outperform fully automated systems.

Conversely, conversational agents may also assist FLEs (Huang and Rust, 2018). One key area relates to letting conversational agents handle routine interactions with customers, while FLEs may focus on complex customer interactions. One such example is Travelbird using conversational software to deal with over 900,000 incoming customer queries per year. More precisely, its software analyzes incoming messages in order to route them to the correct internal response team, presents FLEs with an AI-suggested response and automates iterative requests. As a result, FLEs no longer deal with trivial customer requests but instead invest their time dealing with higher-level tasks. Research is needed to understand the conditions under which FLE–conversational agent collaboration generates positive/negative FLE outcomes (e.g. (dis)engagement, (dis) satisfaction), when FLEs consider AI-agents as genuine co-workers (or co-bots), and what mechanisms are needed to foster FLE–agent collaboration.

Conversational agent and service organization considerations. Service managers need to decide how and what type(s) of conversational agent(s) may be integrated into the service process. Research is needed to understand the trade-off between conversational agent effectiveness (i.e. enhanced customer/FLE satisfaction, loyalty, etc.) and efficiency (i.e. cost-effective usage of conversational agents), when conversational agents should substitute or work in conjunction with FLEs, what metrics are needed to evaluate conversational agent performance and what capabilities are needed to integrate conversational agents into the organization. Moreover, future work should establish the conditions under which conversational agents can contribute to a cost-effective service excellence strategy (Wirtz and Zeithaml, 2018), as well as harness innovation potential by collecting and analyzing customer insights at the frontline.

An equally important decision is whether or not service organizations should take control of the conversational interfaces its customers use? Today, agent interactions dominantly run through third-party platforms (e.g. Amazon Alexa) and hardware (e.g. Amazon Echo). Some organizations like Capital One develop their own conversational interfaces, while others like Uber, Walmart, Sephora and Starbucks are partnering up with the dominating tech giants to develop dedicated conversational services that run through the latter's platforms and hardware (Wilson *et al.*, 2017b). More research is needed looking into the growing impact of third-party agents, and whether a winning managerial strategy involves collaborating or competing with third-party platforms?

Finally, as virtual agents infuse the customer journey, algorithmic decision making will become dominant and digital agents will start acting as gatekeepers (André *et al.*, 2018). This begs the question of how customer perceptions of the organizational frontline change? Are managers losing their influence on the organizational frontline? If skilled digital agents start making decisions for customers, customers' allegiance may shift from trusted brands to trusted digital agents. This may have major implications for traditional service branding, and the role of service marketers. More precisely, does the nature of service branding change from "marketing to customers" to "marketing to machines?" Much like search engine optimization, managers will need to figure out how they may influence algorithms to favor their respective offerings, thereby enhancing customer acquisition and retention success.

Research Area 2: extended reality technologies

Another promising technology field is that of XR, comprising augmented reality (AR), mixed reality (MR) and virtual reality (VR) technologies. Similar to conversational agents, XR technologies can be placed along a reality–virtuality continuum (Milgram and Kishino, 1994 – see Figure 3). At the reality end, AR technologies allow for the digital overlay of images, videos and information to the user's real environments (Brengman *et al.*, 2018). Consider the example of IKEA, which launched an AR app – IKEA Place – allowing customers to place true-to-scale 3D furniture in their home through the lens of their smartphone. At the virtuality end, VR technologies comprise computer-simulated 3D environments in which users are fully immersed, being engaged through one or more human senses (e.g. ability to look around 360°, the sensation of moving, etc. – Van Kerrebroeck *et al.*, 2017). Volvo, for instance, introduced a full VR test drive of its XC90 model. In between, MR technologies combine elements of AR and VR. More precisely, MR technologies overlay and anchor digital(real) objects within a real(digital) environment (Microsoft, 2018a). One example is RoboRaid in which gamers fight against virtual robots that appear in their real physical environment through Microsoft's HoloLens.

XR technologies are relevant to all archetypes (with the exception of type A – see Table I). Although there is a growing body of literature on XR, many challenges remain (Ostrom *et al.*, 2015). We again consider research questions related to XR design, and its implications on customers, FLEs and the service organization.

XR design considerations. A first important design consideration resides in selecting the appropriate platform that fits with the purpose and audience of the XR application. An XR platform can either be dedicated (e.g. Facebook's Oculus) or non-dedicated (e.g. smartphone in combination with Google Cardboard) (Brengman *et al.*, 2018; Guttentag, 2010). While non-dedicated platforms currently allow for a much bigger spread of XR applications, dedicated platforms have the benefit of delivering higher quality XR experiences (Guttentag, 2010). To this end, more research is needed to understand the impact of dedicated vs non-dedicated XR platforms on customer/FLE experience. Moreover, XR platforms typically incorporate an important hardware component, such as smartphones, tablets, smart glasses, head-mounted displays (HMD) and 3D experience rooms (Ganapathy, 2013). Future research may compare the effectiveness of various hardware solutions and establish design guidelines for each. In particular, more research is needed to understand how individual hardware design characteristics (e.g. screen size of a

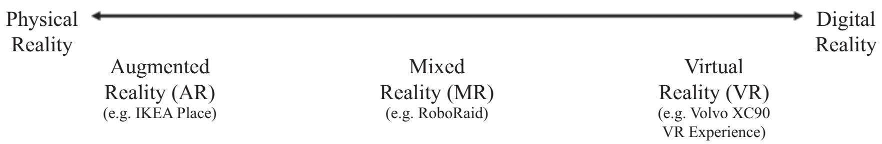


Figure 3. Extended reality technologies

smartphone, weight of an HMD and surface of a 3D experience room) impact the XR experience, and what best practices should be followed.

Further, XR platforms are often complemented with input devices such as joysticks, trackpads and data gloves that allow users to actively participate and interact with the XR environment (Guttentag, 2010). For instance, IKEA's VR application allows users to cook in a virtual kitchen and hold various items by means of a joystick. Researchers may consider to what extent active user participation via input devices (as opposed to passive observation) in an XR environment enhances user outcomes (e.g. sense of telepresence, purchase intentions and satisfaction). Further, building on an observation by Hilken *et al.* (2018), user movements through input devices are often incongruent with actual behaviors in real-life. Grabbing a cup in a VR environment, for instance, typically involves virtually clicking on a button, rather than actually holding the cup. More research is needed to understand the impact of behavioral incongruences on users' perceptions of XR applications, and how various input devices enhance or diminish the intuitivism of XR.

A second design consideration relates to the XR interface, which is reflective of the human senses being addressed. Today, audio and visual stimuli are dominant in the XR realm. Bose AR, for instance, places audio in one's environment, providing location-specific information to its user, while Microsoft's HoloLens combines visual display with audio to create an XR environment. More research is needed to understand if and how both interfaces impact users differently, and what drives user preferences. In relation to visual interfaces, researchers may also compare how different modalities (e.g. images, videos and text) influence XR users. Of particular interest would be the impact of varying levels of visual density (i.e. the amount of information displayed) and positioning (i.e. the arrangement of the information) on the XR experience.

Although visual and auditory formats are currently dominating the XR market, there is a growing interest in haptic, olfactory and gustatory interfaces (Guttentag, 2010). Sense Glove, a Dutch XR startup, has developed a new technology allowing users to physically feel and handle virtual objects, while Tokyo-based Vaqso has developed an odor emitting attachment for HMDs. Future research might consider how these novel interfaces may enhance user interaction and immersion within XR, and in what organizational frontline situations (e.g. "test-driving" a service) they are deemed important. Moreover, given the importance of sensory marketing (Krishna, 2012), more work is needed to compare the effects of distinct XR interfaces and/or their combinations on user outcomes (e.g. sense of telepresence, purchase intentions, satisfaction and user disbelief in XR authenticity). In particular, researchers may consider in what situations XR leads to sensory overload causing users to either miss part of the XR experience or even develop feelings of XR sickness (Kim *et al.*, 2018; Krishna, 2012).

XR and customer considerations. Although the XR realm is still in its early stages, initial research findings support that XR may positively impact various customer outcomes, including engagement, purchase intentions, word of mouth and satisfaction (e.g. Beck and Crié, 2018; Brengman *et al.*, 2018; Hilken *et al.*, 2018). However, practitioner reports claim that customers are let down by current XR applications, driven in part by inflated expectations and disbelief in their authenticity (Panetta, 2017). Given these confounding observations, more research is needed to understand how, when and where along the service journey XR may contribute most to the frontline customer experience (see Rauschnabel *et al.*, 2018 for an initial study on the drivers of AR acceptance). Similar to conversational agents, XR research might benefit from multichannel literature to explain these observations: What factors (e.g. enjoyment, informational quality, ease-of-use, social signaling, shopping goals and XR platform quality) drive XR adoption and the suspension of users' disbelief in XR authenticity (Rafaeli *et al.*, 2017)? How do individual differences (e.g. age, gender, cultural values, previous experiences, technology readiness and information processing preference) impact XR perceptions? In what ways can XR enhance customer outcomes – e.g., does the use of XR lead to higher decision confidence (Hilken *et al.*, 2018)?

When XR applications become mainstream, HMDs and smart glasses are likely to dominate many service environments. One important consideration relates to whether or not this dehumanizes the organizational frontline? And if so, how does this impact customer engagement with the organizational frontline? Wu *et al.* (2015) found customer perceptions of wearable-enhanced FLEs to vary across gender and service situation (i.e. failure vs success). Furthermore, the appearance of XR tools also raises multiple questions related to customer feelings of privacy. To what extent do customers wish to avoid service settings in which FLEs and/or customers use XR tools? How can service organizations protect customer privacy in an XR environment? To what extent are customers willing to share their personal data with XR tools?

XR and FLE considerations. The rise of XR applications holds many promises for FLEs. One area of interest is that of FLE training. Walmart, for instance, successfully uses VR training to help its FLEs better interact with customers in real-life settings through virtual training scenarios. Not only do FLE evaluations go up, but the overall training satisfaction is also significantly higher compared to traditional training methods (STRIVR, 2018). Despite initial findings on the effectiveness of virtual training, research is still relatively rare (Bertram *et al.*, 2015). More insights are needed into whether XR-enabled training prepares FLEs to better deal with customers compared to traditional training methods. Does XR training transfer easily to real-life situations? To what extent will the rise of XR training provide a boost to corporate FLE training in general?

Next to training, FLEs may also use XR tools to interact with customers. Lowe's Hologram experience, for instance, is significantly enhancing FLE abilities to deal with customers. Making use of telemetry data, Lowe's FLEs can conjure up a heat map providing insights into where customers spent the most time looking at the virtual kitchen. In addition, automated verbal sentiment analysis displays the reactions of customers in these various regions of the kitchen (Microsoft, 2018b). Building on similar examples, future research designs should focus on whether and how XR may assist in increasing FLE performance and productivity. Furthermore, research is needed assessing whether the use of XR may lead to higher levels of FLE motivation, reduced mental effort and/or decreased levels of role stress (Rafaeli *et al.*, 2017).

Similarly, research is needed to establish under what conditions XR solutions may enhance or diminish the FLE–customer relationship when interacting from a distance. Initial findings on telehealth show negative effects of service separation, including physician depersonalization, disempowerment and loss of identity (Green *et al.*, 2016). While the negative effects may in part be driven by the typical "high-touch" nature of healthcare services, the reverse effect might be present for traditionally "low-touch" service settings like call centers. Here, a typical troubleshooting call involves a FLE asking customers to describe their problems, which may be hard due to miscommunication or a lack of technical knowledge. To help solve this issue, Microsoft introduced a remote assistance app for its HoloLens, enabling customers to visually share their environment with FLEs who, in turn, may draw virtual instructions on the customer's environment to help them solve most issues.

Finally, customers wearing HMDs and smart glasses at the organizational frontline may significantly impact FLE behaviors and engender feelings of privacy invasion given the inherent recording capabilities of most XR tools. United Airlines, for instance, issued a note to its staff instructing them that they might be recorded by passengers at all times (Drescher, 2017). While initial research on employee monitoring demonstrates both positive (e.g. higher productivity) and negative (e.g. lower empowerment) effects on employee behavior and performance (Bernstein, 2014), more research is needed to understand the impact of XR-augmented customers on FLEs. To what extent are employees hindered by customers' usage of XR hardware? Does the usage of customer XR hardware impact employee well-being? Does the fear of being recorded inhibit FLE empowerment? Do FLEs go the extra mile for XR-augmented customers or does the reverse hold true?

XR and service organization considerations. A first consideration relates to how and what type of XR applications may be adopted by the service organization. Looking at popular press, there are various perspectives as to what type of XR – AR, VR and MR – has the biggest potential to enhance FLE/customer experiences. More research is needed to understand the various trade-offs between AR, VR and MR: How may AR, VR and MR contribute differently to the service journey? What service functions (e.g. information provision, complaint handling, after-sales intervention) match best with what XR type?

Equally important is to understand the business value of XR applications. Given that XR applications are often used to allow customers to preview a service or product, Guttentag (2010) raised the question as to whether some customer segments consider XR a substitute for a real-life experience. While Beck and Crié (2018) showed that XR may foster additional sales by triggering customer curiosity, this effect may not hold true in all situations. If one can visit the Rome Colosseum through VR, for instance, does this increase or decrease the likelihood of an actual visit? Research might consider if and when XR complements and/or substitutes existing service channels. What service settings are most prone to XR substitution? How can organizations identify customer segments sensitive to XR substitution? What tactics may serve to inhibit potential business damage (e.g. restricting the XR experience)?

Finally, service researchers may explore ways through which organizations can monetize the usage of XR, and potentially attract new (vulnerable) customer segments. Dutch entertainment park Efteling, for instance, made its top attraction – Dreamflight – accessible for visitors with disabilities through VR. In doing so, Efteling enhances service inclusion (Fisk *et al.*, 2018) for vulnerable customer groups by engaging them in various service processes.

Research Area 3: blockchain

Blockchain is considered by many as the next breakthrough technology, having the potential to alter many everyday activities and (digital) business processes (Woodside *et al.*, 2017). Blockchains are essentially distributed ledgers that cryptographically store sequential lists (i.e. blocks) of value-exchange transactions (e.g. currencies, property titles, signatures, licenses, patents and digital keys) between networked actors in a consistent, immutable and decentralized manner (Engelhardt, 2017; Gatteschi *et al.*, 2018; Risius and Spohrer, 2017). One such example is Walmart's use of the IBM food safety blockchain to digitize the entire food supply chain process from farmer to end-consumer. Every partner in the supply chain receives access to a blockchain on which they report handling of the food, along with test data, temperature data and certifications. All data entries are saved on blockchain ledgers and allow end-to-end traceability of any food item that reaches the consumer in a matter of seconds. Hence, blockchain technology's key advantages lie in the provision of data transparency (i.e. data and their history are accessible by blockchain users), immutability (i.e. data cannot be erased or altered), redundancy (i.e. data are stored on multiple nodes), decentralization (i.e. blockchain can run without a central authority, working as a peer-to-peer system) and safety (i.e. consensus between the nodes is necessary for a blockchain to be updated) (Savelyev, 2018).

Blockchain technologies are relevant to all archetypes presented earlier (except for Type A – see Table I). Despite its promise, little service research has focused on the implications of blockchain technology. In what follows, we again consider relevant future research topics related to blockchain design, and its implications for customers, FLEs and the service organization.

Blockchain design considerations. Blockchain is still in its early implementation phase and best practices are lacking to provide managerial guidance. Building on Walsh *et al.* (2016) and Risius and Spohrer (2017), eight key properties are central to blockchain design: data access (i.e. who can view data on the blockchain?); permission types (i.e. who may validate and record data on the blockchain?); consensus mechanisms (i.e. what mechanism is used to safeguard and update the blockchain?); modularity (i.e. how flexible is the blockchain for additions?); scalability (i.e. how fast can transactions be processed?); interoperability (i.e. can the blockchain communicate with other blockchains, IoT devices, etc.?); level of centralization (i.e. who controls the blockchain?); and anonymity (i.e. is the identity of the users known?). So far, academic research on each of these topics has been topical and restricted to individual applications (Risius and Spohrer, 2017). Therefore, research should focus on comprehensively understanding the effects and relative importance of each individual blockchain property on customers, FLEs and service organizations, respectively. For instance, in relation to data access, a key decision relates to whether the organization introduces a public or a private blockchain (Walsh *et al.*, 2016). The information on a public blockchain (e.g. Bitcoin) is open for anyone to read, whereas private blockchains restrict access to a pre-defined set of users. While private blockchains give control to service providers, they may cause prospective users to be wary of the blockchain (Berke, 2017). Research is needed to understand how (prospective) customers respond to private vs public blockchains, and to what extent these convey different levels of organizational trust. Next to understanding single effects, research should also focus on understanding how various trade-offs are made between design dimensions. One important trade-off, for example, is that between the consensus mechanism to secure the blockchain and blockchain scalability (Walsh *et al.*, 2016). Tighter consensus mechanisms require more computational power and cause transactions to be processed at a much slower pace. This, in turn, raises scalability issues and might constrain blockchain adoption by service organizations or lead to negative customer/FLE reactions. To this end, novel work recognizing current best practices from blockchain leaders and identifying benchmarks would have significant managerial value.

Blockchain and customer considerations. The introduction of blockchain technology may have several implications for customers and their attitude toward service organizations making use of it. One particular topic of interest is blockchain's enhanced data security (Berke, 2017). Given the importance of cyber-security and the negative effects of data breaches (Martin *et al.*, 2017), blockchain systems might prove a valuable investment to gain customer confidence in the organization. Future research should consider to what extent customers demonstrate higher levels of trust toward blockchain safety as opposed to regular database systems. Another issue relates to the immutable nature of blockchain. To what extent are customers open to an infinite logging of their behaviors and interactions? Moreover, as blockchain technology allows for the removal of traditional third-party service intermediaries, research could investigate whether such omission leads to an increase or decrease of customer trust levels.

At the same time, the transparent nature of blockchain matches growing customer demands for organizational transparency (Aung and Chang, 2014) and integrity (Felicitas *et al.*, 2015). Similar to Walmart, Carrefour implemented blockchain technology to trace the full product journey of its poultry. Via an app, customers can access the poultry's journey and find out where and how each animal was raised, the name of the farmer, the food used, the (medical) treatments delivered, quality labels and where they were processed. Initial academic findings seem to suggest that product/service traceability has a positive impact on customer trust levels and purchase intentions (e.g. Matzembacher *et al.*, 2018). More research is needed to establish the extent to which blockchain-enabled transparency positively impacts outcomes like customer trust, willingness-to-pay, service/product quality perceptions and sales. Moreover, research might consider in what product/service settings blockchain traceability is most prudent and under what conditions (e.g. high vs low brand familiarity) traceability effects are stronger/weaker.

Blockchain and FLE considerations. Blockchain technology may impact FLEs in various ways. Building further on the Carrefour example, it is clear that enhanced data transparency may aid FLEs in performing their job. In particular, product/service traceability might enable FLEs to better respond to customer queries and complaints. Previous research has shown that clear and precise explanations during service recovery are critical to customer evaluations, yet data to do so may not always be available to the FLE (Van Vaerenbergh and Orsingher, 2016). Future research might discuss how blockchain systems may support complaint management and to what extent FLEs feel better equipped to deal with customer complaints. FLEs in the Walmart and Carrefour pilot cases, for instance, can provide immediate answers to customer queries about specific food items and address complaints in more detail.

Furthermore, research may consider how blockchain technology can aid FLEs in recognizing and preventing dysfunctional customer behaviors such as cheating, property abuse and/or the usage of false documents. These behaviors pose a significant threat to many service organizations, negatively impacting FLEs ability to perform their job (Harris and Reynolds, 2003). When opening a bank account, for instance, customers may provide false identity information which is hard for FLEs to check on their accuracy and correctness. Yet, blockchain-enabled digital identities make it harder for customers to misuse and/or spread (false) information (Chester, 2017).

Similarly, the transparency of blockchain may prevent FLE misbehavior. As FLE actions and usage of data are registered on a blockchain through an identifier, they can be better held responsible for their actions. To this end, researchers might investigate how blockchain technology can enhance FLE performance monitoring, and to what extent it limits sabotaging behaviors. Conversely, fear of retribution and feelings of constant monitoring may act as a negative force and create job dissatisfaction and burnout. Previous research demonstrates the positive effects of stewardship-based control mechanisms (Schepers *et al.*, 2012), questioning whether blockchain may effectively be used for FLE control.

Blockchain and service organization considerations. Given that blockchain technology is still in its early stage, perhaps, the easiest step into the blockchain realm involves accepting cryptocurrencies like Bitcoin, Ethereum, Litecoin and EOS. As the cryptocurrency market is growing at a rapid pace, several major retailers and digital players like Overstock.com, Expedia and Microsoft have started accepting payments in Bitcoin. Initial reports from Overstock suggest that acceptance of cryptocurrency generates additional sales and stimulates customer acquisition. However, the volatilely of cryptocurrencies also makes organizations financially vulnerable. When Bitcoin shed half of its value in January 2018, Overstock's valuation fell 11 percent due to a $200m loss (O'Neal, 2018). Research is needed to establish the business value of cryptocurrencies and may focus on the following questions: To what extent does the acceptance of cryptocurrency payments give way to novel business opportunities? What customer segments are prone to cryptocurrency payment? How big are the business and financial risks related to cryptocurrency exchanges?

The more recent introduction of blockchain-enabled smart contracts characterizes a push toward fully automated service encounters (Archetype H). Smart contracts are "pieces of code stored on a blockchain that are programmed to behave in a given manner when certain conditions are met. They can be executed automatically without control of a third party" (Gatteschi *et al.*, 2018, p. 64). Smart contracts for car insurance, for instance, can be programmed to transfer money only if customers repair a car at certified mechanics. As soon as the repair operation is added to the blockchain by a certified mechanic, insurance money is automatically transferred to the customer without any further human involvement. This evolution raises a new set of questions. What services are prone to automation by means of smart contracts? How far does the customer/FLE substitution potential of smart contracts reach? When are customers willing to convert to smart contracts? To what extent do smart contracts enhance service quality levels (e.g. convenience, speed)? Importantly, smart contracts may also drive the further implementation of IoT devices. Whereas the latter serve to take data from the "real" world (e.g. lack of soda in the fridge) and push them onto a blockchain, the former can execute based on the data provided and its rules (e.g. order soda at the retailer with the lowest price). Future research is needed to understand how smart contracts may enable the real breakthrough of IoT devices by pushing their value proposition (e.g. enhanced safety, usability – Risius and Spohrer, 2017).

The rise of blockchain-enabled smart contracts also opens up significant opportunities for service innovation and new business models (Risius and Spohrer, 2017). One particular area of interest is the sharing economy. Blockchain alternatives are already appearing, such as Beenest for home sharing and Snagride for car sharing. Currently, sharing services mainly rely on intermediary platforms like Airbnb and Uber to connect users and providers. The decentralized nature of blockchain systems might alter this model (Risius and Spohrer, 2017). Traditional systems levy high fees for using their platforms and might misuse their centrally gathered private customers' data. Blockchain systems, on the contrary, have the potential to be less expensive to use and provide more transparency as well as security to the customer. Researchers in this area might look into this: To what extent may blockchain technology further support and/or alter the rise of the sharing economy? How are sharing economy platforms such as Uber and Airbnb threatened by the decentralization aspects of blockchain?

Concluding remarks

The organizational frontline is facing an unprecedented evolution as technology becomes increasingly dominant in the service environment (Singh *et al.*, 2017). Smart technologies and connected objects are set to change service as we know it, and meaningfully impact the other entities of the service pyramid: customers, FLEs and the service organization. In this paper, we have sought to understand how these new technologies are impacting the service pyramid, with a particular focus on the customer–FLE–technology triad. More precisely, we provided an updated overview of FTS infusion archetypes and organized these around the augmenting and substituting roles of technology. In addition, we selected three novel technologies relevant to all identified archetypes – conversational agents, XR and blockchain technology – and present various research directions in relation to their impact on the entire service pyramid.

We acknowledge and encourage other researchers to explore further research opportunities related to other promising technologies like 3D printing, bio-technologies (e.g. biometric scanning and DNA personalization) and nanotechnology. Moreover, we also urge future work to account for public policy and ethical considerations (e.g. consequences of FST usage on the education system, FST legal inferences) and broader societal implications (e.g. FST usage at the Base of the Pyramid, FST usage for an ageing population, FST for service inclusion; Fisk *et al.*, 2018) related to novel FSTs. Future work might also consider expanding the current archetypes to account for more complex interactions between networks and systems of human entities, service organizations and smart technologies.

It is clear that many challenges remain in the emergent field of organizational frontline research. Today, business practice and academic disciplines such as computer science may have a head start in understanding the implications of new technologies for service. Yet, no field is as equipped as the academic service community to tackle these challenges head on. Therefore, it is our hope that this paper contributes to the further development of service research in this burgeoning area.

Notes

1. It is important to note that the archetypes in this study are reflective of discrete service touchpoints, and do not represent full-service journeys that may involve multiple encounters.
2. We recognize that FLEs in this archetype are often referred to as back-office employees in practice. Yet, these employees are the first to interact with the customers' technology stand-in, making them FLEs in this interaction.
3. Each of the identified archetypes requires a different set of FLE and/or customer skills and resources from the service organization to overcome burdens linked with an encounter type (Hazée *et al.*, 2017). It is important for managers to carefully consider the various FLE (e.g. need for training and support), customer (e.g. need for education, resistance toward adoption) and organizational (e.g. business model impact) consequences that may arise from implementing a specific archetype for service delivery, and from transitioning from one type to another.
4. Specifically, we thank Paul Gemmel (Ghent University), Simon Hazée (HEC Liége) Werner Kunz (University of Massachusetts Boston), Bart Larivière (KU Leuven), Lia Patricio (University of Porto), Yves Van Vaerenbergh (KU Leuven), Katrien Verleye (Ghent University), Rohit Verma (Cornell University), Chris Voss (Warwick Business School), Jochen Wirtz (National University of Singapore), and the members of the Center for Service Intelligence (Ghent University) and the CTF Service Research Center (Karlstad University) for their valuable input in selecting key FSTs for the future.

References

Admoni, H. and Scassellati, B. (2017), "Social eye gaze in human-robot interaction: a review", *Journal of Human-Robot Interaction*, Vol. 6 No. 1, pp. 25-63.

Ahearne, M., Jones, E., Rapp, A. and Mathieu, J. (2008), "High touch through high tech: the impact of salesperson technology usage on sales performance via mediating mechanisms", *Management Science*, Vol. 54 No. 4, pp. 671-685.

Akaka, M.A. and Vargo, S.L. (2014), "Technology as an operant resource in service (eco)systems", *Information Systems and E-Business Management*, Vol. 12 No. 3, pp. 367-384.

André, Q., Carmon, Z., Wertenbroch, K., Crum, A., Frank, D., Goldstein, W., Huber, J., van Boven, L., Weber, B. and Yang, H. (2018), "Consumer choice and autonomy in the age of artificial intelligence and big data", *Customer Needs and Solutions*, Vol. 5 No. 1, pp. 28-37.

Araujo, T. (2018), "Living up to the chatbot hype: the influence of anthropomorphic design cues and communicative agency framing on conversational agent and company perceptions", *Computers in Human Behavior*, Vol. 85, pp. 183-189.

Aung, M.M. and Chang, Y.S. (2014), "Traceability in a food supply chain: safety and quality perspectives", *Food Control*, Vol. 39, pp. 172-184.

Beck, A., Cañamero, L. and Bard, K.A. (2010), "Towards an affect space for robots to display emotional body language", *19th International Symposium in Robot and Human Interactive Communication*, pp. 464-469.

Beck, M. and Crié, D. (2018), "I virtually try it … I want it ! Virtual fitting room: a tool to increase on-line and off-line exploratory behavior, patronage and purchase intentions", *Journal of Retailing and Consumer Services*, Vol. 40, pp. 279-286.

Berke, A. (2017), "How safe are blockchains? It depends", *Harvard Business Review*, available at: https://hbr.org/2017/03/how-safe-are-blockchains-it-depends (accessed July 10, 2018).

Bernstein, E. (2014), "How being filmed changes employee behavior", *Harvard Business Review*, available at: https://hbr.org/2014/09/how-being-filmed-changes-employee-behavior (accessed August 3, 2018).

Berry, L.L., Seiders, K. and Grewal, D. (2002), "Understanding service convenience", *Journal of Marketing*, Vol. 66 No. 3, pp. 1-17.

Bertram, J., Moskaliuk, J. and Cress, U. (2015), "Virtual training: making reality work?", *Computers in Human Behavior*, Vol. 43, pp. 284-292.

Bitner, M.J., Booms, B.H. and Tetreault, M.S. (1990), "The service encounter – diagnosing favorable and unfavorable incidents", *Journal of Marketing*, Vol. 54 No. 1, pp. 71-84.

Bolton, R. and Saxena-Iyer, S. (2009), "Interactive services: a framework, synthesis and research directions", *Journal of Interactive Marketing*, Vol. 23 No. 1, pp. 91-104.

Bolton, R.N., McColl-Kennedy, J.R., Cheung, L., Gallan, A.S., Orsingher, C., Witell, L. and Zaki, M. (2018), "Customer experience challenges: bringing together digital, physical and social realms", *Journal of Service Management*, Vol. 29 No. 5, pp. 776-808.

Bowen, D.E. (2016), "The changing role of employees in service theory and practice: an interdisciplinary view", *Human Resource Management Review*, Vol. 26 No. 1, pp. 4-13.

Brengman, M., Willems, K. and Van Kerrebroeck, H. (2018), "Can't touch this: the impact of augmented reality versus touch and non-touch interfaces on perceived ownership", *Virtual Reality*, forthcoming.

Buvat, J., Taylor, M., Jacobs, K., Khadikar, A. and Sengupta, A. (2018), "Conversational commerce: why consumers are embracing voice assistants in their lives", available at: www.capgemini.com/wp-content/uploads/2018/01/dti-conversational-commerce.pdf (accessed June 10, 2018).

Čaić, M., Odekerken-Schröder, G. and Mahr, D. (2018), "Service robots: value co-creation and co-destruction in elderly care networks", *Journal of Service Management*, Vol. 29 No. 2, pp. 178-205.

Callejas, Z., Griol, D. and López-Cózar, R. (2014), "A framework for the assessment of synthetic personalities according to user perception", *International Journal of Human-Computer Studies*, Vol. 72 No. 7, pp. 567-583.

Cameron, D., Millings, A., Fernando, S., Collins, E.C., Moore, R., Sharkey, A., Evers, V. and Prescott, T. (2018), "The effects of robot facial emotional expressions and gender on child–robot interaction in a field study", *Connection Science*, pp. 1-19.

Castro-González, Á., Admoni, H. and Scassellati, B. (2016), "Effects of form and motion on judgments of social robots' animacy, likability, trustworthiness and unpleasantness", *International Journal of Human-Computer Studies*, Vol. 90, pp. 27-38.

Chester, J. (2017), "How the blockchain will secure your online identity", *Forbes*, available at: www.forbes.com/sites/jonathanchester/2017/03/03/how-the-blockchain-will-secure-your-online-identity/#7cd7328b5523 (accessed July 6, 2018).

Coeckelbergh, M., Pop, C., Simut, R., Peca, A., Pintea, S., David, D. and Vanderborght, B. (2016), "A survey of expectations about the role of robots in robot-assisted therapy for children with ASD: ethical acceptability, trust, sociability, appearance, and attachment", *Science and Engineering Ethics*, Vol. 22 No. 1, pp. 47-65.

Cunningham, L.F., Young, C.E. and Gerlach, J.H. (2008), "Consumer views of self-service technologies", *The Service Industries Journal*, Vol. 28 No. 6, pp. 719-732.

Dabholkar, P.A. (1994), "Technology-based service delivery: a classification scheme for developing marketing strategies", in Brown, S.W., Swartz, T.A. and Bowen, D.E. (Eds), *Advances in Services Marketing and Management: Research and Practice*, 3rd ed., JAI Press, Greenwich, CT, pp. 241-271.

De Keyser, A., Schepers, J. and Konus, U. (2015), "Multichannel customer segmentation: does the after-sales channel matter? A replication and extension", *International Journal of Research in Marketing*, Vol. 32 No. 4, pp. 453-456.

Deloitte (2016), "Global mobile consumer trends: 1st Edition Mobile proves to be indispensable in an always-connected world", available at: www2.deloitte.com/content/dam/Deloitte/us/Documents/technology-media-telecommunications/us-tmt-global-mobile-consumer-trends-first-edition-2016.pdf (accessed June 12, 2018).

Deloitte (2018), "Tech Trends 2018 – the symphonic enterprise", available at: www2.deloitte.com/tr/en/pages/technology-media-and-telecommunications/articles/tech-trends-2018.html (accessed August 1, 2018).

Ding, X., Verma, R. and Iqbal, Z. (2007), "Self-service technology and online financial service choice", *International Journal of Service Industry Management*, Vol. 18 No. 3, pp. 246-268.

Dong, B., Sivakumar, K., Evans, K.R. and Zou, S. (2015), "Effect of customer participation on service outcomes: the moderating role of participation readiness", *Journal of Service Research*, Vol. 18 No. 2, pp. 160-176.

Drescher, C. (2017), "United Airlines tells flight crews to assume they're always on camera", *The Independent*, available at: www.independent.co.uk/travel/news-and-advice/united-airlines-flight-crews-staff-video-camera-david-dao-secret-memo-smartphones-onboard-a7727436.html (accessed August 3, 2018).

Engelhardt, M.A. (2017), "Hitching healthcare to the chain: an introduction to blockchain technology in the healthcare sector", *Technology Innovation Management Review, Talent First Network, Ottawa*, Vol. 7 No. 10, pp. 22-34.

Felicitas, M., Lucia, M., Amélie, G., Florent, G. and Bianca, G. (2015), "Brand authenticity: an integrative framework and measurement scale", *Journal of Consumer Psychology*, Vol. 25 No. 2, pp. 200-218.

Fink, J. (2012), "Anthropomorphism and human likeness in the design of robots and human-robot interaction", in Ge, S.S., Khatib, O., Cabibihan, J.-J., Simmons, R. and Williams, M.-A. (Eds), *Social Robotics*, Springer, Berlin and Heidelberg, pp. 199-208.

Fisk, R.P., Dean, A., Alkire, L., Joubert, A., Previte, J., Robertson, N. and Rosenbaum, M.S. (2018), "Design for service inclusion: creating inclusive service systems", *Journal of Service Management*, Vol. 29 No. 5, pp. 834-858.

Fong, T., Nourbakhsh, I. and Dautenhahn, K. (2003), "A survey of socially interactive robots: concepts, design, and applications", *Robotics and Autonomous Systems*, Vol. 42 Nos 3-4, pp. 143-166.

Frey, C.B. and Osborne, M.A. (2017), "The future of employment: how susceptible are jobs to computerisation?", *Technological Forecasting and Social Change*, Vol. 114, pp. 254-280.

Froehle, C.M. (2006), "Service personnel, technology, and their interaction in influencing customer satisfaction", *Decision Sciences, Wiley Online Library*, Vol. 37 No. 1, pp. 5-38.

Froehle, C.M. and Roth, A.V. (2004), "New measurement scales for evaluating perceptions of the technology-mediated customer service experience", *Journal of Operations Management*, Vol. 22 No. 1, pp. 1-21.

Ganapathy, S. (2013), "Design guidelines for mobile augmented reality: user experience", in Huang, W., Alem, L. and Livingston, M.A. (Eds), *Human Factors in Augmented Reality Environments*, Springer, New York, NY, pp. 165-180.

Gartner (2017), "Gartner top 10 strategic technology trends for 2018", available at: www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2018/ (accessed May 2, 2018).

Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C. and Santamaria, V. (2018), "To blockchain or not to blockchain: that is the question", *IT Professional*, Vol. 20 No. 2, pp. 62-74.

Giebelhausen, M., Robinson, S.G., Sirianni, N.J. and Brady, M.K. (2014), "Touch versus tech: when technology functions as a barrier or a benefit to service encounters", *Journal of Marketing*, Vol. 78 No. 4, pp. 113-124.

Green, T., Hartley, N. and Gillespie, N. (2016), "Service providers experiences of service separation: the case of telehealth", *Journal of Service Research*, Vol. 19 No. 4, pp. 477-494.

Grewal, D., Ahlbom, C.-P., Beitelspacher, L., Noble, S.M. and Nordfält, J. (2018), "In-store mobile phone use and customer shopping behavior: evidence from the field", *Journal of Marketing*, Vol. 82 No. 4, pp. 102-126.

Griol, D., Carbó, J. and Molina, J.M. (2013), "An automatic dialog simulation technique to develop and evaluate interactive conversational agents", *Applied Artificial Intelligence*, Vol. 27 No. 9, pp. 759-780.

Guttentag, D.A. (2010), "Virtual reality: applications and implications for tourism", *Tourism Management*, Vol. 31 No. 5, pp. 637-651.

Harris, L.C. and Reynolds, K.L. (2003), "The consequences of dysfunctional customer behavior", *Journal of Service Research*, Vol. 6 No. 2, pp. 144-161.

Hazée, S., Delcourt, C. and Van Vaerenbergh, Y. (2017), "Burdens of access: understanding customer barriers and barrier-attenuating practices in access-based services", *Journal of Service Research*, Vol. 20 No. 4, pp. 441-456.

Hilken, T., de Ruyter, K., Chylinski, M., Mahr, D. and Keeling, D.I. (2017), "Augmenting the eye of the beholder: exploring the strategic potential of augmented reality to enhance online service experiences", *Journal of the Academy of Marketing Science, Journal of the Academy of Marketing Science*, Vol. 45 No. 6, pp. 884-905.

Hilken, T., Heller, J., Chylinski, M., Keeling, D.I., Mahr, D. and de Ruyter, K. (2018), "Making omnichannel an augmented reality: the current and future state of the art", *Journal of Research in Interactive Marketing*, Vol. 12 No. 4, pp. 509-523.

Hoffman, D.L. and Novak, T.P. (2017), "Consumer and object experience in the Internet of Things: an assemblage theory approach", *Journal of Consumer Research*, Vol. 44 No. 6, pp. 1178-1204.

Holz, T., Dragone, M. and O'Hare, G.M.P. (2009), "Where robots and virtual agents meet", *International Journal of Social Robotics*, Vol. 1 No. 1, pp. 83-93.

Holz, T., Campbell, A.G., O'Hare, G.M.P., Stafford, J.W., Martin, A. and Dragone, M. (2011), "MiRA – Mixed Reality Agents", *International Journal of Human-Computer Studies*, Vol. 69 No. 4, pp. 251-268.

Homburg, C., Jozíc, D. and Kuehnl, C. (2017), "Customer experience management: toward implementing an evolving marketing concept", *Journal of the Academy of Marketing Science*, Vol. 45 No. 3, pp. 377-401.

Huang, M.H. and Rust, R.T. (2017), "Technology-driven service strategy", *Journal of the Academy of Marketing Science, Journal of the Academy of Marketing Science*, Vol. 45 No. 6, pp. 906-924.

Huang, M.-H. and Rust, R.T. (2018), "Artificial intelligence in service", *Journal of Service Research*, Vol. 21 No. 2, pp. 155-172.

IBM (2017), "10 reasons why AI-powered, automated customer service is the future", available at: www.ibm.com/blogs/watson/2017/10/10-reasons-ai-powered-automated-customer-service-future/ (accessed July 10, 2018).

Jaimes, A. and Sebe, N. (2007), "Multimodal human–computer interaction: a survey", *Computer Vision and Image Understanding*, Vol. 108 No. 1, pp. 116-134.

Kannan, P.K. and Li, H. (2017), "Digital marketing: a framework, review and research agenda", *International Journal of Research in Marketing*, Vol. 34 No. 1, pp. 22-45.

Karray, F., Alemzadeh, M., Saleh, J.A. and Arab, M.N. (2008), "Human-computer interaction: overview on state of the art", *International Journal on Smart Sensing and Intelligent Systems*, Vol. 1 No. 1, pp. 137-159.

Kim, H.K., Park, J., Choi, Y. and Choe, M. (2018), "Virtual reality sickness questionnaire (VRSQ): motion sickness measurement index in a virtual reality environment", *Applied Ergonomics*, Vol. 69, pp. 66-73.

Kimes, S.E. and Collier, J.E. (2015), "How customers view self-service technologies", *MIT Sloan Management Review*, Vol. 57 No. 1, pp. 25-26.

Krämer, N.C., Bente, G., Eschenburg, F. and Troitzsch, H. (2009), "Embodied conversational agents", *Social Psychology*, Vol. 40 No. 1, pp. 26-36.

Krishna, A. (2012), "An integrative review of sensory marketing: engaging the senses to affect perception, judgment and behavior", *Journal of Consumer Psychology*, Vol. 22 No. 3, pp. 332-351.

Kumar, V., Dixit, A., Javalgi, R.G. and Dass, M. (2016), "Research framework, strategies, and applications of intelligent agent technologies (IATs) in marketing", *Journal of the Academy of Marketing Science*, Vol. 44 No. 1, pp. 24-45.

Larivière, B., Bowen, D., Andreassen, T.W., Kunz, W., Sirianni, N.J., Voss, C., Wünderlich, N.V. and De Keyser, A. (2017), "'Service Encounter 2.0': an investigation into the roles of technology, employees and customers", *Journal of Business Research*, Vol. 79, pp. 238-246.

Li, J. (2015), "The benefit of being physically present: a survey of experimental works comparing copresent robots, telepresent robots and virtual agents", *International Journal of Human-Computer Studies*, Vol. 77, pp. 23-37.

Marinova, D., de Ruyter, K., Huang, M.-H., Meuter, M.L. and Challagalla, G. (2017), "Getting smart: learning from technology-empowered frontline interactions", *Journal of Service Research*, Vol. 20 No. 1, pp. 29-42.

Martin, K.D., Borah, A. and Palmatier, R.W. (2017), "Data privacy: effects on customer and firm performance", *Journal of Marketing*, Vol. 81 No. 1, pp. 36-58.

Mathur, M.B. and Reichling, D.B. (2016), "Navigating a social world with robot partners: a quantitative cartography of the Uncanny Valley", *Cognition*, Vol. 146, pp. 22-32.

Matzembacher, D.E., do Carmo Stangherlin, I., Slongo, L.A. and Cataldi, R. (2018), "An integration of traceability elements and their impact in consumer's trust", *Food Control*, Vol. 92, pp. 420-429.

Mende, M., Scott, M.L., van Doorn, J., Shanks, I. and Grewal, D. (2017), "Service robots rising: how humanoid robots influence service experiences and food consumption", Working Paper Series No. 17-125-10, Marketing Science Institute, Cambridge, MA, available at: www.msi.org/reports/service-robots-rising-how-humanoid-robots-influence-service-experiences-and/

Meuter, M.L., Ostrom, A.L., Roundtree, R.I. and Bitner, M.J. (2000), "Self-service technologies: understanding customer satisfaction with technology-based service encounters", *Journal of Marketing*, Vol. 50 No. 64, pp. 50-64.

Microsoft (2018a), "What is mixed reality?", available at: https://docs.microsoft.com/en-us/windows/mixed-reality/mixed-reality (accessed July 20, 2018).

Microsoft (2018b), "Case study – lessons from the Lowe's kitchen", available at: https://docs.microsoft.com/en-us/windows/mixed-reality/case-study-lessons-from-the-lowes-kitchen (accessed August 2, 2018).

Milgram, P. and Kishino, F. (1994), "A taxonomy of mixed reality visual-displays", *IEICE Transactions on Information and Systems*, Vol. E77D No. 12, pp. 1321-1329.

Mimoun, M.S.B. and Poncin, I. (2015), "A valued agent: how ECAs affect website customers' satisfaction and behaviors", *Journal of Retailing and Consumer Services*, Vol. 26, pp. 70-82.

Ng, I.C.L. and Wakenshaw, S.Y.L. (2017), "The Internet-of-Things: review and research directions", *International Journal of Research in Marketing*, Vol. 34 No. 1, pp. 3-21.

Novak, T.P. and Hoffman, D.L. (2018), "Relationship journeys in the Internet of Things: a new framework for understanding interactions between consumers and smart objects", *Journal of the Academy of Marketing Science*, forthcoming.

O'Neal, S. (2018), "The history of overstock, e-commerce Bitcoin pioneer facing unclear future", *Cointelegraph*, available at: https://cointelegraph.com/news/the-history-of-overstock-e-commerce-bitcoin-pioneer-facing-unclear-future (accessed July 5, 2018).

Ostrom, A.L., Parasuraman, A., Bowen, D.E., Patricio, L. and Voss, C.A. (2015), "Service research priorities in a rapidly changing context", *Journal of Service Research*, Vol. 18 No. 2, pp. 127-159.

Paluch, S. (2014), "Customer expectations of remote maintenance services in the medical equipment industry", *Journal of Service Management*, Vol. 25 No. 5, pp. 639-653.

Paluch, S. and Blut, M. (2013), "Service separation and customer satisfaction: assessing the service separation/customer integration paradox", *Journal of Service Research*, Vol. 16 No. 3, pp. 415-427.

Panetta, K. (2017), "Top trends in the Gartner Hype Cycle for emerging technologies, 2017", Gartner, available at: www.gartner.com/smarterwithgartner/top-trends-in-the-gartner-hype-cycle-for-emerging-technologies-2017/ (accessed July 28, 2018).

Parasuraman, A. (1996), "Understanding and leveraging the role of customer service in external, interactive and internal marketing", *Frontiers in Service Conference, Nashville, TN*.

Parasuraman, A. (2000), "Technology Readiness Index (TRI): a multiple-item scale to measure readiness to embrace new technologies", *Journal of Service Research*, Vol. 2 No. 4, pp. 307-320.

Rafaeli, A., Altman, D., Gremler, D.D., Huang, M.-H., Grewal, D., Iyer, B., Parasuraman, A. and de Ruyter, K. (2017), "The future of frontline research: invited commentaries", *Journal of Service Research*, Vol. 20 No. 1, pp. 91-99.

Rapp, A., Baker, T.L., Bachrach, D.G., Ogilvie, J. and Beitelspacher, L.S. (2015), "Perceived customer showrooming behavior and the effect on retail salesperson self-efficacy and performance", *Journal of Retailing*, Vol. 91 No. 2, pp. 358-369.

Rauschnabel, P.A., He, J. and Ro, Y.K. (2018), "Antecedents to the adoption of augmented reality smart glasses: a closer look at privacy risks", *Journal of Business Research*, Vol. 92, pp. 374-384.

Risius, M. and Spohrer, K. (2017), "A blockchain research framework", *Business & Information Systems Engineering*, Vol. 59 No. 6, pp. 385-409.

Roy Chowdhury, I., Patro, S., Venugopal, P. and Israel, D. (2014), "A study on consumer adoption of technology-facilitated services", *Journal of Services Marketing*, Vol. 28 No. 6, pp. 471-483.

Rust, R.T. and Huang, M.-H. (2014), "The service revolution and the transformation of marketing science", *Marketing Science*, Vol. 33 No. 2, pp. 206-221.

Savelyev, A. (2018), "Copyright in the blockchain era: promises and challenges", *Computer Law & Security Review*, Vol. 34 No. 3, pp. 550-561.

Schepers, J., Falk, T., de Ruyter, K., de Jong, A. and Hammerschmidt, M. (2012), "Principles and principals: do customer stewardship and agency control compete or complement when shaping frontline employee behavior?", *Journal of Marketing*, Vol. 76 No. 6, pp. 1-20.

Schumann, J.H., Wünderlich, N.V. and Wangenheim, F. (2012), "Technology mediation in service delivery: a new typology and an agenda for managers and academics", *Technovation*, Vol. 32 No. 2, pp. 133-143.

Shankar, V., Kleijnen, M., Ramanathan, S., Rizley, R., Holland, S. and Morrissey, S. (2016), "Mobile shopper marketing: key issues, current insights, and future research avenues", *Journal of Interactive Marketing*, Vol. 34, pp. 37-48.

Shook, E. and Knickrehm, M. (2018), "Reworking the revolution", available at: www.key4biz.it/wp-content/uploads/2018/01/Accenture-8343-Davos-Future-Workforce-WEB-A4-POV-AW-GG.pdf (accessed August 8, 2018).

Singh, J., Brady, M., Arnold, T. and Brown, T. (2017), "The emergent field of organizational frontlines", *Journal of Service Research*, Vol. 20 No. 1, pp. 3-11.

Solomon, M.R., Surprenant, C., Czepiel, J.A. and Gutman, E.G. (1985), "A role theory perspective on dyadic interactions: the service encounter", *Journal of Marketing, American Marketing Association*, Vol. 49 No. 1, pp. 99-111.

Spaid, B.I. and Flint, D.J. (2014), "The meaning of shopping experiences augmented by mobile internet devices", *Journal of Marketing Theory and Practice*, Vol. 22 No. 1, pp. 73-90.

STRIVR (2018), "How can we make our training more consistent, engaging and effective?", available at: www.strivr.com/wp-content/uploads/2018/04/STRIVR-Walmart-Case-Study.pdf (accessed July 28, 2018).

Tay, B.T.C., Low, S.C., Ko, K.H. and Park, T. (2016), "Types of humor that robots can play", *Computers in Human Behavior*, Vol. 60, pp. 19-28.

Tuzovic, S. and Paluch, S. (2018), "Conversational commerce – a new era for service business development?", in Bruhn, M. and Hadwich, K. (Eds), *Service Business Development: Strategien – Innovationen – Geschäftsmodelle. Band 1*, Springer Fachmedien Wiesbaden, Wiesbaden, pp. 81-100.

van Doorn, J., Mende, M., Noble, S.M., Hulland, J., Ostrom, A.L., Grewal, D. and Petersen, J.A. (2017), "Domo Arigato Mr Roboto: emergence of automated social presence in organizational frontlines and customers' service experiences", *Journal of Service Research*, Vol. 20 No. 1, pp. 43-58.

Van Kerrebroeck, H., Brengman, M. and Willems, K. (2017), "Escaping the crowd: an experimental study on the impact of a virtual reality experience in a shopping mall", *Computers in Human Behavior*, Vol. 77, pp. 437-450.

Van Vaerenbergh, Y. and Orsingher, C. (2016), "Service recovery: an integrative framework and research agenda", *Academy of Management Perspectives*, Vol. 30 No. 3, pp. 328-346.

Verhoef, P.C., Stephen, A.T., Kannan, P.K., Luo, X., Abhishek, V., Andrews, M., Bart, Y., Datta, H., Fong, N., Hoffman, D.L., Hu, M., Novak, T., Rand, W. and Zhang, Y. (2017), "Consumer connectivity in a complex, technology-enabled, and mobile-oriented world with smart products", *Journal of Interactive Marketing*, Vol. 40, pp. 1-8.

Walsh, C., O'Reilly, P., Gleasure, R., Feller, J., Li, S. and Cristoforo, J. (2016), "New kid on the block: a strategic archetypes approach to understanding the blockchain", *International Conference on Information Systems*, pp. 1-12.

Wilson, H.J., Daugherty, P.R. and Morini Bianzino, N. (2017a), "The jobs that artificial intelligence will create", *MIT Sloan Management Review*, Vol. 58 No. 4, pp. 14-16.

Wilson, H.J., Daugherty, P.R. and Morini Bianzino, N. (2017b), "When AI becomes the new face of your brand", *Harvard Business Review*, available at: https://hbr.org/2017/06/when-ai-becomes-the-new-face-of-your-brand (accessed June 27, 2018).

Wilson, J.R., Lee, N.Y., Saechao, A., Hershenson, S., Scheutz, M. and Tickle-Degnen, L. (2017), "Hand gestures and verbal acknowledgments improve human-robot rapport", in Kheddar, A., Yoshida, E., Ge, S.S., Suzuki, K., Cabibihan, J.-J., Eyssel, F. and He, H. (Eds), *Social Robotics*, Springer International Publishing, Cham, pp. 334-344.

Wirtz, J. and Zeithaml, V. (2018), "Cost-effective service excellence", *Journal of the Academy of Marketing Science*, Vol. 46 No. 1, pp. 59-80.

Wirtz, J., Patterson, P.G., Kunz, W.H., Gruber, T., Nhat Lu, V., Paluch, S. and Martins, A. (2018), "Brave new world: service robots in the frontline", *Journal of Service Management*, Vol. 29 No. 5, pp. 907-931.

Woodside, J.M., Augustine, F.K.J. and Giberson, W. (2017), "Blockchain technology adoption status and strategies", *Journal of International Technology and Information Management*, Vol. 26 No. 2, pp. 65-93.

Wu, L., Fan, A. (Aileen) and Mattila, A.S. (2015), "Wearable technology in service delivery processes: the gender-moderated technology objectification effect", *International Journal of Hospitality Management*, Vol. 51, pp. 1-7.

Wünderlich, N.V., Heinonen, K., Ostrom, A.L., Patricio, L., Sousa, R., Voss, C. and Lemmink, J.G.A.M. (2015), " 'Futurizing' smart service: implications for service researchers and managers", *Journal of Services Marketing*, Vol. 29 Nos 6/7, pp. 442-447.

Yadav, M.S. and Pavlou, P.A. (2014), "Marketing in computer-mediated environments: research synthesis and new directions", *Journal of Marketing*, Vol. 78 No. 1, pp. 20-40.

Złotowski, J., Proudfoot, D., Yogeeswaran, K. and Bartneck, C. (2015), "Anthropomorphism: opportunities and challenges in human–robot interaction", *International Journal of Social Robotics*, Vol. 7 No. 3, pp. 347-360.

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