Journal of Business Research xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

Digital information flows across a B2C/C2C continuum and technological innovations in service ecosystems: A service-dominant logic perspective

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ARTICLE INFO

Keywords:
Digital information flow continuum
Service-dominant logic
Service ecosystems
Service innovations
Telemedicine
Value co-creation

ABSTRACT

Value co-creation for service innovations involves integrating inputs from multiple actors within service ecosystems. Traditionally, value co-creation has been considered in light of business-to-consumer (B2C) interactions. The emergence of digital information platforms allowing consumer-to-consumer (C2C) communications is changing how service ecosystems establish and create value for service innovations. In this paper, we develop a Digital Information Flow Continuum that includes B2C, external provider and consumer co-created (B2C/C2C combined) and C2C digital communications. Using Service-Dominant Logic (SDL), we assess the impact digital information flow elements have on the perceptions and usage likelihood for telemedicine (TM) services. We use structural equation modeling to analyze online survey results from 827 health consumers collected as part of a healthcare organization's TM launch. The results demonstrate that the Digital Information Flow Continuum impacts the acceptance of the TM innovation directly, and indirectly through value perceptions of comparable service quality relative to alternatives and ease of access to care.

1. Introduction

Value enhancing innovations have the potential to positively or negatively impact service ecosystems (Dedehayir, Ortt, & Seppänen, 2017; Reinhardt & Gurtner, 2018). Academic researchers are particularly interested in innovations that focus on digital services (Larivière et al., 2017), and especially those that have the potential to transform service delivery via new processes, technologies, and deliverables (Chandler, Danatzis, Wernicke, Akaka, & Reynolds, 2019). Digital information and digital service delivery represent the use of online resources and platforms available to learn about and utilize innovations (i.e., Internet, social media, apps, etc.). For example, researchers have investigated digital service delivery in mobile banking (Payne, Peltier, & Barger, 2018) and digital health (Dahl, Milne, & Peltier, 2019). A common thread across this evolving research stream is that technology-based innovations impact how employees interface with customers and the extent to which consumers benefit from these digital service encounters (Larivière et al., 2017).

Marketing communications are critical to the launch, acceptance, and adoption of innovations within service ecosystems (Alexander, Jaakkola, & Hollebeck, 2018). Although business-to-consumer (B2C) communications play a key role in the adoption process, marketers are going beyond B2C information flows and dyadic relationships, to digital marketing platforms that allow consumers to create and share information amongst themselves, thereby co-creating value for a service innovation (Chandler & Vargo, 2011). Service experiences have thus transitioned from pure "one-to-one" communication and engagement processes to "many-to-many" informational touchpoints (Vargo & Lusch, 2016). Framed through the lens of Service-Dominant Logic (SDL) (Vargo & Lusch, 2017), actors within service ecosystems co-create value for innovations through the sharing of unique experiences with and perceptions of the innovation. Despite this interest, research is limited on how B2C and consumer-to-consumer (C2C) information flows impact the acceptance and adoption of service innovations (Gruner, Vomber, Homburg, & Lukas, 2019). Although the literature has begun to investigate interaction mechanisms needed to support value co-creation in service ecosystems, the role of communication integration is not well understood. Virtually silent is research showing how different digital formats and platforms along an information flow continuum from B2C to C2C impact consumers' perceptions of service innovations and adoption likelihood (Dahl et al., 2019; Kim & Baker, 2017).

Responding to calls for research that investigates how multi-actor communications impact service ecosystems (Vargo & Lusch, 2016), we develop a B2C/C2C Digital Information Flow Continuum and assess

Abbreviations: B2C, business-to-consumer; C2C, consumer-to-consumer; SDL, service-dominant logic; TM, telemedicine

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https://doi.org/10.1016/j.jbusres.2020.03.020
Received 30 April 2019; Received in revised form 12 March 2020; Accepted 14 March 2020

how consumers use different elements along this continuum to co-create value for technological service innovations. Our continuum has three digital information flows - B2C, external provider and consumer co-created (B2C/C2C combined), and C2C. We assess our Digital Information Flow Continuum in the context of telemedicine (TM). TM represents a technological service innovation in healthcare that allows patients to receive primary and specialty care using a device and location of the patient's choice (Swan, Dahl, & Peltier, 2019). Using SDL, we investigate how B2C/C2C digital information flow elements impact the perceived benefits of TM (comparative service quality relative to alternatives and access benefits) and TM usage likelihood. Consistent with SDL, our findings show that the elements of the Digital Information Flow Continuum differentially impact how value is co-created, including perceptions of TM and usage likelihood. We contribute to the SDL and service ecosystems literature by showing how actors independently and jointly impact the acceptance and adoption of service innovations.

We structure the paper as follows. We first briefly introduce TM as a service-altering technology-based innovation, followed by an introduction to the SDL literature in the context of service ecosystems and our Digital Information Flow Continuum. We then present our model and hypotheses. We outline our method and measures, test our model, and conclude with a discussion of results, implications, and future research needs.

2. Theoretical background

2.1. Telemedicine

The health service ecosystem continues to evolve as technological innovations provide consumers with the option to receive professional medical care at the time and location of their choice (Shah et al., 2018). TM is defined as "a platform that allows patients to be seen by healthcare providers from any location using a smartphone, tablet, and/or computer with audio and video capabilities" (Swan et al., 2019). TM allows consumers to interact with healthcare providers virtually from a distance. Consumers first answer a set of pre-qualifying questions to determine if their care situation is appropriate for TM-based delivery. If appropriate conditions are met, the system connects consumers with an available health provider. TM represents a service-altering innovation on a number of levels (Swan et al., 2019) in that patients don't have to travel to the provider's physical location, and that consumers increasingly form decisions on whether to seek out care based on information found online such as search engines (i.e. Google), online symptom checkers like WebMD.com, or opinions shared via social media platforms (Haluza, Naszay, Stockinger, & Jungwirth, 2017). Given this service delivery paradigm shift, healthcare organizations must manage customer interactions and expectations related to a combination of health professionals, digital technology platforms, and health information sources as part of the expanding service ecosystem (Patrício & Fisk, 2011).

2.2. Service-dominant logic and service ecosystems

SDL focuses on how value creation occurs (Vargo & Lusch, 2004, 2017). SDL reflects a paradigm shift that places service exchange (not goods) and consumers (not producers) at the center of value creation (Vargo & Lusch, 2004). Under this perspective, value is defined and co-created by the consumer (Vargo & Lusch, 2016), and co-creation only exists if the consumer is actively involved in the process and engaged throughout the service exchange through a 'value-in-use' concept (Grönroos & Voima, 2013). Three core principles of the SDL perspective have important value co-creation implications related to the context of successfully launching innovations in service ecosystems.

First, an emerging SDL ecosystems perspective suggests that a complex network exists involving interrelationships and communications among multiple participants that go beyond the typical consumer-service provider dyad (Grönroos & Voima, 2013). Value co-creation is increasingly coordinated through actor-generated institutions and arrangements that reflect multiple stakeholders within the ecosystem (Vargo & Lusch, 2016). Specific to TM, the service ecosystem includes actors representing the supply-side (i.e., service designers, providers, and marketers), demand-side (i.e., TM users, other health system consumers), and payer-side (i.e., insurers, government). External experts and media coverage may also contribute information that influences consumers' understanding of how to navigate and enhance value co-creation within the health services ecosystem. Consequently, each of these actors may play a critical role in the TM service innovation design, perceptions, and adoption processes that contribute to value co-creation. Information flows between these multiple actors are critical to helping consumers (and other network members) recognize and co-create TM value.

Second, SDL considers 'service' to reflect any process of exchanging information and other operant resources (Vargo & Lusch, 2008). Operant resources reflect the personal skills and knowledge each participant uses during the service exchange (Vargo & Lusch, 2004), and serves as the primary basis of exchange (Vargo & Lusch, 2008). Value co-creation is thus enhanced when all participating actors and influencers contribute their respective inputs as part of the exchange (Grönroos & Ravald, 2011). In a TM context, the service provider's core operant resources include the health professional's skills and medical expertise that enables the provider to diagnose and deliver care that aligns with a patient's needs. A consumer's core operant resources include contextual information and knowledge regarding their health symptoms, other situational factors, as well as personal motivations and channel preferences for seeking health services informed through information search before the service interaction. The ecosystem network participants can help TM consumers become more effective contributors to value co-creation when information flows enhance a consumer's knowledge, skills, and understanding of when and how to navigate the TM ecosystem (Grönroos & Voima, 2013).

Third, efficient resource integration and utilization of the limited operant resources available to service participants are critical to ecosystem value co-creation (Vargo & Lusch, 2004). Consumers experience information asymmetry in health service ecosystems when they feel their providers and current social networks offer insufficient insights for making appropriate health care decisions (Marcozzi, Carr, Liferidge, & Baehr, 2018). Information asymmetry and other systematic inefficiencies thus negatively impact co-value creation and lead to poor decision-making related to optimal health service behaviors (Dahl et al., 2019). Consumers are likely to seek out external information and resources to reduce information asymmetry to help judge the viability of service innovations (Dahl, Peltier, & Milne, 2018; Grönroos & Voima, 2013).

2.3. Information flow in service ecosystems

Successful service innovation adoption is more likely to occur when consumers are actively engaged in bidirectional communication that enables the service provider to adapt the service offerings to align with changing consumer needs (Gustafsson, Kristensson, & Witell, 2012). Consumers also need communications that will help them understand appropriate system utilization. TM technology platforms offer increased opportunities for information exchange that can contribute to this enhanced value co-creation (Henry, Shen, Ahuja, Gould, & Kanter, 2016). The consumer's role in TM encounters is even more important as consumers have increased responsibility for sharing information that shapes the service delivery process since the care takes place at-a-distance (Grönroos & Voima, 2013). The patient must be able to communicate key aspects of their health situation via the TM system to maximize value co-creation while overcoming any reservations about information asymmetry due to the complex nature of the health services

ecosystem. Service providers can help patients by integrating appropriate resources and information flows which provides a basis for the co-creation of value (Vargo & Lusch, 2008).

As noted above, although the consumer plays a central role, a variety of actors within the TM service ecosystem contribute to the innovation's value chain. The TM service ecosystem experiences maximum value co-creation when the different actors interact and utilize various communication flows to improve service experience or awareness and understanding of the innovation (Vargo & Lusch, 2016). On one side of the ecosystem, healthcare organizations, frontline service providers, other healthcare professionals, insurance companies, and marketers contribute to value co-creation through service design and disseminating communications (i.e., B2C) that highlight the potential value co-created via the TM service encounter (Ballantyne, Frow, Varey, & Payne, 2011; Pera, Occhiocupo, & Clarke, 2016). These supply-side actors develop value propositions and bring to market TM services that increase consumers' access to healthcare.

Consumers represent the demand-side of the service ecosystem and primarily experience personal value co-creation from TM through the notion of value-in-use through convenient access to quality care (Vargo & Lusch, 2008). Consumers experience maximum value co-creation by communicating their health needs and preferences to the service provider, and when both parties integrate their resources during the service encounter (Grönroos & Ravald, 2011). Consumers have shown increased interest in integrating informational inputs obtained before the service encounter from other health-related digital resources (Dahl et al., 2019). SD suggests consumers experience enhanced value co-creation as they integrate these resources along with health providers' applied skills and knowledge during the TM encounter (McColl-Kennedy, Vargo, Dagger, Sweeney, & van Kasteren, 2012; Vargo & Lusch, 2004).

The information flows can also influence consumers' decision-making to seek care via TM or in-person, thus co-creating value for the supply-side actors through increased usage of health service offerings (Letaifa, Edvardsson, & Tronvoll, 2016). Health providers and other demand-side actors that encourage consumers' TM usage may increase consumers' value perceptions of the service ecosystem, and in turn, benefit the healthcare firm via enhanced consumer satisfaction, increased consumer loyalty, and lower healthcare costs (Cossio-Silva, Revilla-Camacho, Vega-Vazquez, & Palacios-Florencio, 2016). As consumers utilize TM, consumers can co-create value for the service ecosystem by identifying additional service improvements (Larivière et al., 2017). Consumers further contribute to the service innovation value chain as they help promote the benefits of using TM to other consumers via C2C-information sharing (McColl-Kennedy et al., 2012). Combined, greater consumer engagement in the TM service ecosystem may influence others to adopt and benefit from the innovation (Vargo & Lusch, 2017).

2.4. Digital information flow continuum: An SDL perspective

Although researchers are showing increased interest, much of the extant SDL literature is theoretical, and research is necessary that empirically examines how the multi-actor information flows influence value co-creation in service ecosystems such as TM (Vargo & Lusch, 2017). Larivière et al. (2017) contend that service ecosystems are entering a new era in which service providers (current provider and other provider sources), technologies, and customers play a key role in information creation, dissemination, and sharing. The interactions between actors and the knowledge resources they possess are thus core enablers for the acceptance (or rejection) of innovations (McColl-Kennedy, Hogan, Witell, & Snyder, 2017; Storbacka, Brodie, Böhmann, Maglio, & Nenonen, 2016). In this way, inter-actor communication encounters are key mechanisms that turn information reciprocity and collaboration into value co-creation of service innovations (Ballantyne et al., 2011; Pera et al., 2016). Information reciprocity and collaboration can take place across any communication platform, (Ballantyne, 2004), ranging from personal, electronic and print media, online messaging, and social networks, all of which provide interaction mechanisms for supporting value co-creation (Breidbach & Brodie, 2017).

Traditionally, service providers viewed customers as passive recipients of information (Jang & Chung, 2014). As digital platforms have emerged, there is a growing consensus that C2C communications play an increased role in brand and service acceptance (Sreejesh, Sarkar, Sarkar, Eshghi, & Anusree, 2017). Information flows have thus transitioned from at-arms-length communication processes to interactive processes in which consumers access and share information from a multitude of digital sources (Letaifa et al., 2016). Specific to healthcare, Dahl et al. (2019) suggest that consumers have access to information resources across multiple digital platforms and message sources, including (1) provider-created digital information; (2) external health provider websites (i.e., Mayo Clinic) and online symptom checkers (i.e., WebMD) that also offer C2C information sharing capabilities and discussion boards; and (3) social media platforms which are heavily laden with C2C interactions.

Extending Dahl et al. (2019), Fig. 1 conceptualizes our Digital Information Flow Continuum. We conceptualize *Provider-Created Digital Health Information* as B2C communications. Although many health provider websites have social features, the primary purpose is outward-bound information sharing about their services and their institution. *Consumer-Created Digital Health Information (C2C)* anchors the other end of the continuum, with C2C communication exchanges (mostly personal social media platforms) dominating these platforms. Lastly, *External Provider and Consumer Co-Created Health Information (Combined B2C/C2C)* is positioned between the endpoints of the Digital Information Flow Continuum, and represents external digital websites beyond their providers' control that offer both the opportunity to access health information and C2C discussion opportunities. According to SDL, consumers' external information search is a key resource integration activity that enhances value creation (Dahl et al., 2019; Sweeney, Danaher, & McColl-Kennedy, 2015). Patients are also increasingly turning to external digital information platforms beyond their providers' control. Due to information asymmetry related to health issues, consumers are often unsure whether they should seek out professional medical care given certain symptoms or conditions. For example, Google receives more than 70,000 health-related searches per minute from consumers attempting to understand the meaning of health symptoms, diagnoses, treatments, and related information (Murphy, 2019). Likewise, websites like WebMD.com (> 142 million monthly visits) and MayoClinic.org (> 100 million monthly visits) allow consumers to co-create health solutions by entering their health symptoms, learning about related health issues identified by the site, posting questions, and leaving other consumer-created comments (SimilarWeb, 2019). These 'external' websites provide increased opportunities for co-created information flows including helping consumers ascertain whether to seek care from a healthcare professional and an assessment of the viability and comparative benefits of TM or in-person service encounters for the consumer's specific health issues. Combined, these externally co-created digital resources give patients increased access to data and empower them to be more accountable for their health.

3. Model and hypotheses

Successful rollouts of service innovations require multiple actors to share common value perceptions to increase consumer usage and to maximize value co-creation (Alexander et al., 2018; Chandler et al., 2019). Consumers are likely to seek out and utilize information obtained from across the Digital Information Flow Continuum when considering whether to use an unfamiliar service innovation (Ballantyne et al., 2011). Actors from the supply-side of the service ecosystem (B2C) often hold more information about the service

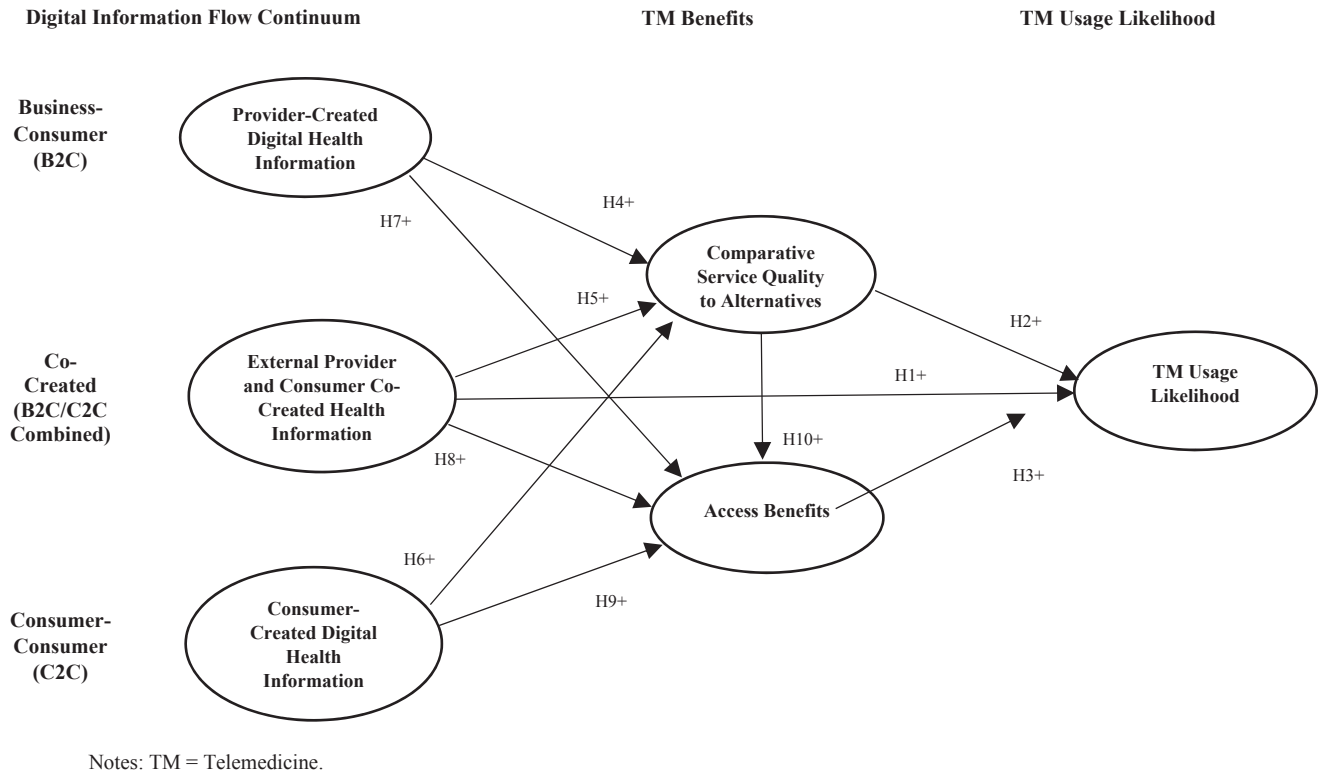

Fig. 1. Digital information flow continuum framework. Notes: TM = Telemedicine.

ecosystem and newly launched service innovations. However, research suggests that consumers may place greater trust in information shared via C2C platforms, thereby increasing the role consumers play in how other consumers evaluate and decide to utilize new service offerings (Labrecque, 2013). It is thus unclear how digital information flows from along the continuum jointly encourage consumers to adopt a service innovation and influence other value perceptions rooted in experiences of the traditional service exchange process. As shown in Fig. 1, our study addresses this gap by examining the impact of consumers' digital health information seeking along the B2C-C2C continuum and its influence on TM usage likelihood.

3.1. Future TM usage likelihood

Consistent with SDL, the healthcare service ecosystem continues to place greater emphasis on consumers and health providers co-producing health outcomes via an expanding array of technologies that enable digital delivery of services and relevant health information (Dahl et al., 2018, 2019). TM allows consumers to remotely interact with a healthcare professional on a schedule that is customer-defined, thereby providing consumers with greater access to care that is convenient for their lifestyle and health decision-making needs (Swan et al., 2019). While TM has promise, skepticism remains as to whether consumers will consider using TM as a long-term substitute for in-person care (Shah et al., 2018).

3.2. Direct paths to TM usage likelihood

3.2.1. Digital information flow and telemedicine usage likelihood

The rise of digital information channels expands consumers' access to information from a variety of sources, including consumer-created information (Chandler & Vargo, 2011; Helkkula, Kowalkowski, & Tronvoll, 2018). Specific to service innovation adoption, digital information resources that consumers seek out may help increase awareness and understanding of the benefits of telemedicine, and what to expect during the service encounter (Ballantyne et al., 2011). Although all digital information flows along the continuum may serve to enhance consumers' perceptions and acceptance of service innovations, SDL places greater emphasis on those that co-create customer value (Grönroos & Voima, 2013).

Based on McColl-Kennedy et al. (2017) and Storbacka et al. (2016), we contend that of the three core elements of our Digital Information Flow Continuum, external provider and consumer co-created (B2B/B2C) digital information is most closely associated with value co-creation because consumers themselves seek out these external platforms and then read/participate in user-generated comments. Consumers also input their health symptoms on these sites to generate a set of likely health issues. Consumers' need to seek out external digital information may be due in part to information asymmetry. Consistent with SDL, external provider and consumer co-created information may help consumers reduce information asymmetry (McColl-Kennedy et al., 2012). We thus posit that external information and resources help consumers judge the viability of the service innovation in relationship to their current health needs (Grönroos & Voima, 2013).

H1. External provider- and consumer co-created digital information seeking (B2C/C2C) will be positively associated with telemedicine usage likelihood.

3.2.2. Comparative service quality relative to alternatives and TM usage likelihood.

The technology adoption literature shows that innovation usage likelihood is based on consumers' value perceptions of the service (Davis, 1989). SDL suggests consumers evaluate value co-created during service encounters by using prior experiences as a critical reference point (Chandler & Lusch, 2015). Consistent with SDL, co-value creation in a TM setting is based on perceptions of the extent to which this new service relationship paradigm leads to joint decision making responsibilities before, during and after the health delivery process (Swan et al., 2019). However, most consumers have yet to personally

experience TM (Shigekawa, Fix, Corbett, Roby, & Coffman, 2018), and therefore will likely base their value perceptions on whether the virtual service encounter will provide comparable service quality to the known, in-person care process (Christensen, Raynor, & McDonald, 2015). Because perceived quality is often lower for early-stage service innovations, acceptance likelihood is in part linked to comparative service quality evaluations relative to existing alternatives (Guo, Pan, Guo, Gu, & Kuusisto, 2019). When consumers believe TM service encounters offer equivalent or superior outcomes relative to their in-person care encounters, their likelihood of adopting the service innovation is expected to increase. Conversely, consumers will be less likely to utilize TM when they have concerns about reliability, privacy, or other quality of care issues (Haluza et al., 2017; Hickson, Talbert, Thornbury, Perin, & Goodin, 2015; Roettl, Bidmon, & Terlutter, 2016).

H2. Comparative service quality relative to alternatives will be positively associated with TM usage likelihood.

3.2.3. Access benefits and TM usage likelihood.

Expanded access to care is often cited as a primary benefit to TM (Hickson et al., 2015; Roettl et al., 2016). Consumers consider TM as expanding access to care when it decreases interruptions to their daily routines and offers the convenience of remotely receiving care from a wider range of providers (Ashwood, Mehrotra, Cowling, & Uscher-Pines, 2017; Shah et al., 2018). TM provides access benefits to health consumers where options may otherwise be limited, thereby making it difficult to schedule an in-person appointment convenient for the consumer (Shigekawa et al., 2018). In a TM context, value co-creation is enhanced when consumers have a greater ability to decide on when health delivery takes place, rather than finding an available time based on the providers' schedule. Consumers are more willing to adopt TM in place of in-person service encounters when TM allows them to receive care at a time and place that is convenient for them (Ashwood et al., 2017; Shah et al., 2018). Specific to technological innovation, convenience alone is not a sole predictor of adoption. Consumers must have the technical capacity to utilize convenience enhancing innovations (Veríssimo, 2016). Consequently, consumers will consider increased access to care as a prerequisite to adopting a service innovation like TM (George, Hamilton, & Baker, 2012).

H3. Access benefits will be positively associated with TM usage likelihood.

3.3. Indirect paths to TM usage likelihood

3.3.1. Digital information flows to comparative service quality relative to alternatives

Consumers judge the comparative value of TM by examining the impact the service delivery process will have on their health compared to the incumbent service (Vargo & Lusch, 2017). Consumers conduct extensive information searches when attempting to compare an unfamiliar service ecosystem to a known process (Chandler & Lusch, 2015; Lusch & Nambisan, 2015). Digital information seeking may expose consumers to a variety of TM-related communications that increase consumers' awareness and understanding of how TM service encounters work and thus inform comparative evaluations to in-person visits. For example, consumer-created messages that highlight positive experiences of TM may help other consumers feel more confident in their ability to leverage the operant resources of the TM technology platform to receive similar outcomes to an in-person encounter (Grönroos & Voima, 2013). Consumers that seek out and integrate a variety of digital health resources are more likely to have positive perceptions of virtual care visits when compared to in-person service encounters (Haluza et al., 2017), and foresee positive outcomes from engaging in TM (Shigekawa et al., 2018). Conversely, George et al. (2012) suggest that consumers integrating less digital health information may have lower quality perceptions of TM. From an SDL perspective, active digital resource integrators are more likely to view benefits of service innovations more positively (Ng & Vargo, 2018; Sweeney et al., 2015). This integration-benefit link is expected to be especially relevant in a TM context given that multiple information dissemination actors provide corroborating evidence of the relative value of TM service delivery to on-site service delivery.

H4. Provider-created digital information seeking will be positively associated with comparative service quality relative to alternatives.

H5. External provider and consumer co-created digital information seeking will be positively associated with comparative service quality relative to alternatives.

H6. Consumer-created digital information seeking will be positively associated with comparative service quality relative to alternatives.

3.3.2. Digital information flows to access benefits

Noted above, access benefits may be viewed along two interrelated service attributes: convenience and capacity to use. SDL implies that consumers determine TM's access benefits by considering their ability to easily integrate resources during the service exchange (Vargo & Lusch, 2017). Ng and Vargo (2018) contend that consumers' capacity and willingness to fully engage with a technology platform will influence utilization of the service innovation. TM usage requires that consumers possess both technological competence and confidence to maximize value-in-use (Ordanini & Parasuraman, 2011). Access perceptions will decrease if consumers perceive extensive effort is necessary to utilize the TM platform (Sweeney et al., 2015). However, as consumers engage in a wider range of digital information seeking, they are likely to feel it will be easier and more convenient to integrate those digital resources into a service encounter that involves digital technology. Consistent with SDL, we posit that:

H7. Provider-created digital information seeking will be positively associated with access benefits.

H8. External provider and consumer co-created digital information seeking will be positively associated with access benefits.

H9. Consumer-created digital information seeking will be positively associated with access benefits.

3.3.3. Comparative service quality relative to alternatives to access benefits

The SDL and TM literature suggests that consumers will not recognize access benefits unless the TM service encounter aligns with their quality expectations and provides relative advantages compared to alternatives (Grönroos & Voima, 2013). George et al. (2012) contend that consumers are less willing to recognize the access benefits when they have low quality perceptions of TM. For example, while TM offers superior access for rural health consumers, access benefits offer little value if TM service delivery fails to meet their expectations (Ashwood et al., 2017). Moreover, Guo et al. (2019) showed that how the quality of a technological innovation compares to the incumbent impacts perceptions of added value. We thus posit that consumers' perceptions of access benefits are positively linked to how perceived TM care delivery compares to the status-quo, which in the current context is their current in-person care alternative (Tsai, Cheng, Tsai, Hung, & Chen, 2019).

H10. Comparative service quality relative to alternatives will be positively associated with access benefits.

4. Materials and methods

4.1. Measurement instrument

We used a multi-stage process to develop the survey and related

Table 1
Respondent profile.

	Sample (n = 827)
Gender	
Male	41.1%
Female	58.9%
Age	
21–44	21.2%
45–54	22.9%
55–64	27.9%
65+	28.0%
Annual Household Income	
< $25,000	6.7%
$25,000–34,999	8.8%
$35,000–49,999	14.9%
$50,000–74,999	25.6%
$75,000+	44.0%
Highest Level of Education	
High school degree/GED or less	28.7%
Associate's/Bachelor's degree	51.3%
Master's degree or higher	20.0%

measures across the five TM dimensions: advisory committee, key informant interviews, and pre-test with 225 patients. Given the infancy of TM, multiple focus groups and interviews with physicians and other expert healthcare professionals were conducted to ascertain potential digital information sources, benefits of TM, barriers to adoption, and usage scenarios. Using factor and reliability analyses, 22 scale items adapted from the existing literature in the context of usage likelihood for TM services were included in the final survey. Three information flow dimensions surfaced, ranging from provider-created (B2C), external provider and consumer co-created (B2C/C2C), and consumer-created (C2C). Two distinct TM benefit/barrier elements were also identified: comparative health delivery and service access.

- *(B2C) Provider-created digital health information seeking* (Dahl et al., 2019): Three-item B2C scale measuring an individual's frequency of using health information from their provider's digital presence, including provider's website, social media platforms, and electronic/online health records (patient portal including items such as visit summaries, test results, physician/healthcare provider messaging, appointments, etc.) (1 = never to 5 = frequently).
- *(B2C/C2C combined) External provider and consumer co-created digital health information seeking* (Dahl et al., 2019): Three-item B2C/C2C scale measuring frequency of using external digital health information created by businesses and providers, but also offering significant opportunities for consumers to generate content including comments on the site and/or via input of their health symptoms. These included other health providers' websites/blogs (i.e. Mayo Clinic), online symptom checker websites (i.e. WebMD), and other health/wellness websites that include B2C information along with C2C commenting and other input capabilities (1 = never to 5 = frequently).
- *(C2C) Consumer-created digital health information seeking* (Dahl et al., 2019): Four-item C2C scale measuring frequency of using digital health information created and shared by consumers outside the control of providers, including, online health/wellness communities or forums, social media sites that share health/wellness info, health/wellness videos on YouTube or other sites that offer commenting, and asking others on social media about symptoms (1 = never to 5 = frequently).
- *Comparative service quality* relative *to alternatives* (original scale): Consumers evaluate service ecosystem innovations in reference to the incumbent service delivery method. Consumers are thus likely to evaluate healthcare services delivered via TM vs. traditional in-person care that occurs in the health provider's office. We used a three-item scale measuring comparative care quality, including, be as thorough as an on-site visit, be as reliable as an on-site visit, and be just as personal as an on-site visit (1 = strongly disagree to 5 = strongly agree).
- *Access to healthcare benefits* (original scale): Five-item scale measuring ease of access benefits associated with TM services, including, make it easy to communicate with health providers, allow patients to receive same day care, reduce the need to miss work/school to receive care, simplify the appointment scheduling process, and improve my access to primary care providers (1 = strongly disagree to 5 = strongly agree).
- *TM Usage Likelihood* (original scale): Four-item scale dependent variable measuring usage likelihood given various scenarios, including, use TM if offered by your current provider, use TM from any health provider, switch to a provider offering TM if your current provider didn't offer, and use TM if offered by your healthcare organization (1 = not at all likely to 5 = very likely).

4.2. Sample and data collection

Data were collected in conjunction with a rural Midwestern hospital that was in the process of launching their TM presence. The sampling frame consisted of email addresses of patients within their health service program who use the hospital as their primary source of care, and have a primary care provider at that hospital. This excluded patients who may have used hospital services, yet live outside of the service area, and/or non-patients who have only utilized emergency services. The initial sample thus compromised of a list of 5,000 patients with a current email address. A drawing for 20 digital blood pressure devices was used an incentive for completing the survey. After three waves, 827 responses were collected (16.5% response rate). Demographic characteristics of the respondents used for hypothesis testing are shown in Table 1.

5. Results

5.1. Confirmatory factor analysis

Initially, 23 questions representing the five theoretical constructs were subjected to an exploratory principle components factor analysis to ensure the quality of the items. Items with factor loadings less than 0.60 and/or multiple factor loadings were dropped from the assessment. Items of each construct were carefully examined to make sure that all items were loaded based on theory. The cumulative variance explained from the exploratory factor analyses was 73.3%, ranging from 9.3% to 22.7% for the individual constructs. All items loaded as expected. A total of 18 items remained for inclusion in the measurement model.

We used AMOS 23 to conduct a confirmatory factor analysis on the remaining 18 items and to validate the measurement model. Items were assigned to latent variables based on the EFA. Although the CMIN/DF was less than the suggested value of 3.0, the overall Chi square statistic of the measurement model was significant (χ^2 = 665, 214 df, CMIN/DF = 2.84, $p < .05$). The significant p-value may be a result of the large sample size. The other model fit statistics suggested a good fit including the GFI (0.95), AGFI (0.93), CFI (0.98), NFI (0.96), and RMSEA (0.04) (Hu & Bentler, 1999). Each of the individual item loadings was significant ($p < .001$) and the completely standardized solution for all items ranged from 0.58 to 0.97, with 17 of the 18 above the preferred 0.7 guideline (Mathwick & Rigdon, 2004). The average variance extracted value (AVE) was 0.63, and all individual AVE's exceed Fornell and Larcker (1981) 0.5 convergent validity criterion. We assessed discriminant validity by verifying that the maximum shared variance (MSV) and average shared variance (ASV) were both less than the AVE for each construct (Hair, 2010). Each of our dimensions were thus unique. Finally, the composite reliability measures ranged from 0.73 to 0.94. In summary, the results suggested that the measures were

Table 2
Measurement items.

Provider-Created Digital Health Information (B2C) (CR = 0.73)
How often do you use each of the below for health/wellness purposes?
(1 = Never to 5 = Frequently)
1. My health provider's website
2. My health provider's social media
3. Electronic/online health records
External Provider and Consumer Co-Created Health Information (B2C/C2C) (CR = 0.81)
How often do you use each of the below for health/wellness purposes?
(1 = Never to 5 = Frequently)
1. Other health providers' websites (i.e. Mayo Clinic)
2. Online symptom checkers (i.e. WebMD)
3. Other health/wellness websites
Consumer-Created Digital Health Information (C2C) (CR = 0.84)
How often do you use each of the below for health/wellness purposes?
(1 = Never to 5 = Frequently)
1. Social media sites that share health/wellness info
2. Asked others on social media about your symptoms
3. Online health/wellness community or forum
4. Health/wellness videos on YouTube or other sites
Comparative Service Quality Relative to Alternatives (CR = 0.90)
TM will**…..**
(1 = Strongly Disagree to 5 = Strongly Agree)
1. Be as thorough as an on-site visit
2. Be as reliable as an on-site visit
3. Be just as personal as an on-site visit
Access Benefits (CR = 0.94)
TM will**…..**
(1 = Strongly Disagree to 5 = Strongly Agree)
1. Improve my access to primary care providers
2. Allow patients to receive same day care
3. Reduce the need to miss work/school to receive care
4. Simplify the appointment scheduling process
5. Make it easy to communicate with health providers
DV = TM Usage Likelihood (CR = 0.89)
I will**…..**
(1 = Very Unlikely to 5 = Very Likely)
1. Use TM if offered by your current provider
2. Use TM from any health provider
3. Switch to a provider offering TM if your current provider didn't offer
4. Use TM if offered by your healthcare organization

distinct and reliable. Table 2 presents the final measurement items. Table 3 provides relevant descriptive statistics.

Finally, we used two post-hoc techniques to check for common methods variance following the procedures outlined by Podsakoff, MacKenzie, Lee, and Podsakoff (2003). First, we calculated Harman's single-factor method in an exploratory factor analysis. The single factor explained only 35% of the variance suggesting common method variance was not an issue. Next, a common latent factor (CLF) was created in the confirmatory factor analysis (CFA). Each individual item was allowed to load on its latent construct and the CLF. Two methods were used to analyze the results of the CFA with CLF. First, we constrained each path and calculated the square of the common variance (0.038). Second, we calculated the deltas of the standardized regression weights by comparing the results of the model with and without the CLF. No deltas were greater than the 0.2 cutoff (absolute values ranged from 0.00 to 0.15). Based on the results, common method variance does not appear to be a concern. Therefore, the final measurement model and structural path models did not control for common method bias.

5.2. Structural paths

We conducted full path analysis of the structural equation model of the stratified sample using AMOS 23, with each item allowed to load on its related latent construct. The Chi square statistic was significant, although this may be due to the sample size (χ^2 = 400, 185 df, CMIN/DF = 2.1, $p < .05$). Therefore, we relied on other model fit statistics to determine if the structural path model provided a satisfactory fit to test the theorized relationships. The GFI (0.96), AGFI (0.94), CFI (0.98), NFI (0.97) and RMSEA (0.036) all met the minimum threshold requirements and indicate the model satisfactorily fits the data (Hu & Bentler, 1999). We tested alternative models one at a time and in combination by varying the order of latent constructs, reversing directional paths (e.g., between comparable service quality relative to alternatives to access benefits), and adding/eliminating paths. None of the alternative models performed as well as the original model or aligned better with theory (Blunch, 2008).

Overall, seven of the ten hypothesized relationships were significant and in the hypothesized positive direction (see Fig. 2). Additionally, the path from external provider and consumer co-created digital health information to comparative service quality relative to alternatives was significant and negative, which was counter to a priori expectations. Table 4 provides the structural model parameter estimates, while Fig. 2 shows the reduced model with significant pathways.

5.3. Direct effects

All three of the direct effects on TM usage likelihood were positive and significant as hypothesized. External provider and consumer co-created (B2C/C2C combined) digital health information seeking (H1: Std β = 0.169, $p < .001$), comparative service quality relative to alternatives (H2: Std β = 0.360, $p < .001$), and access benefits (H3: Std β = 0.350, $p < .001$) were significant. Although not hypothesized, the direct paths to TM from provider-created (B2C) and consumer-created (C2C) digital health information were also evaluated, and were not significant.

5.4. Indirect effects

Five of the seven hypothesized indirect pathways were significant, with one surprising result. First, related to the Digital Health Information Seeking Continuum, both provider-created (B2C) (H6: Std β = 0.188, $p < .001$) and consumer-created (C2C) (H8: Std β = 0.335, $p < .001$) digital health information seeking platforms

Table 3
Descriptive statistics.

Construct	Mean	SD	B2C/C2C	C2C	B2C	ACCESS	COMP	TM USAGE
B2C/C2C	2.4	0.90	1					
C2C	2.5	1.2	0.530	1				
B2C	1.5	0.70	0.545	0.680	1			
ACCESS	3.8	0.74	0.260	0.262	0.348	1		
COMP	3.1	0.84	0.257	0.221	0.292	0.676	1	
TM USAGE	3.0	1.1	0.311	0.351	0.352	0.697	0.569	1

Notes: All sig at $p < .05$. SD = standard deviation, B2C + C2C = external provider and consumer co-created (combined B2C/C2C); C2C = consumer-to-consumer (consumer-created); B2C = business-to-consumer (provider-created); COMP = comparative service quality to alternatives; TM = telemedicine.

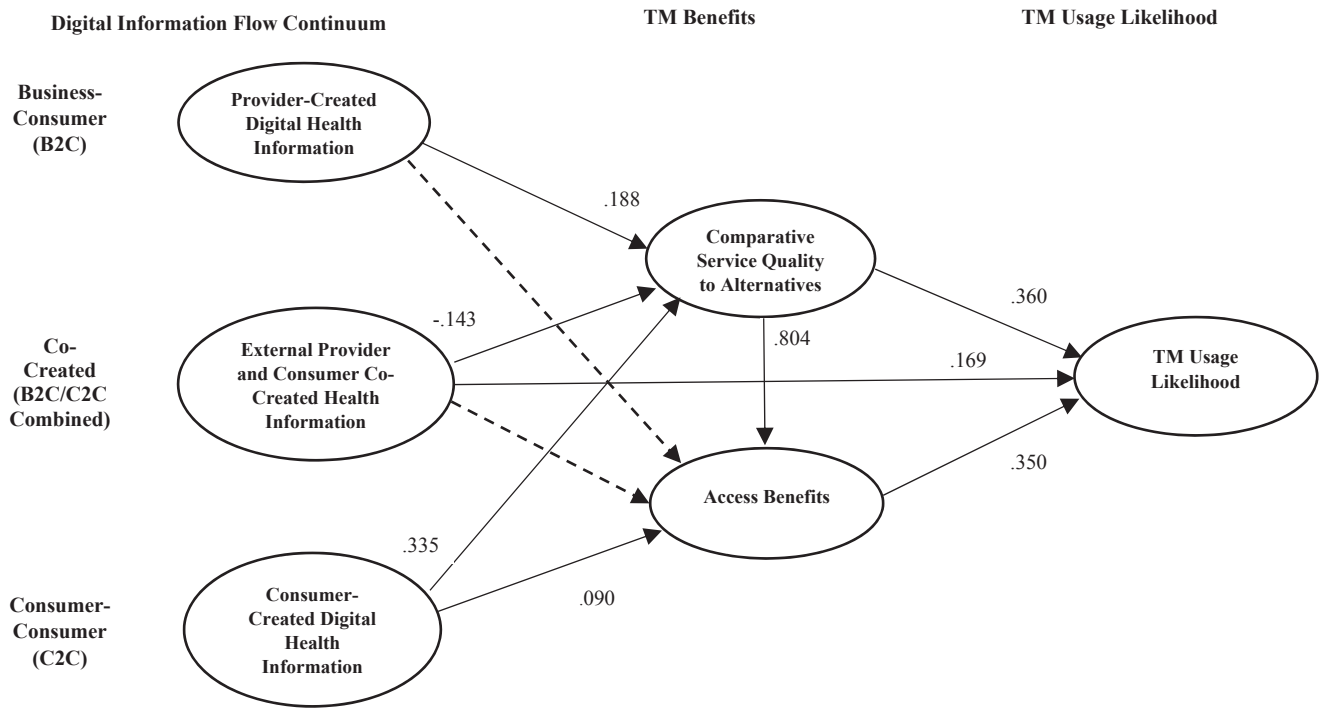

Fig. 2. Final reduced path model. Notes: Dashed lines indicate non-significant paths. TM = Telemedicine.

significantly impacted perceptions of comparative service quality relative to alternatives. Surprisingly, a negative relationship was found between external provider and consumer co-created digital health information seeking (B2C/C2C combined) and comparative service quality relative to alternatives (H7: $\beta = -0.143$, $p < .05$).

Second, of the paths related to the Digital Health Information Continuum, only consumer-created (C2C) significantly impacted perceptions of access benefits (H9: Std $\beta = 0.09$, $p < .01$). Provider-created (H7) and external provider/consumer-created (H8) were not significant. Lastly, comparative service quality relative to alternatives to access benefits was supported (*H*10: Std $\beta = 0.804$, $p < .001$).

5.5. Moderating influences

We also added gender and age demographic moderators to the full structural path model to test for meaningful differences that might reflect a digital divide in how consumers adopt TM. The chi-square difference test indicated no significant differences at the global level for either of the moderators on the overall model. We also compared the critical ratio values to determine if any individual pathways were significantly different between groups and found one significant difference based on gender and three for age. Specifically, the pathway from provider-created (B2C) digital information seeking to comparative benefits was only significant for female consumers ($\beta = 0.272$, $p < .001$, $z = 2.16$). Females are often the primary health decision-maker in most households. The finding suggests that health marketers' efforts to promote TM on the providers' digital presence is particularly critical to enhancing female consumers' perceptions of TM's comparative benefits and in turn encouraging these consumers to utilize TM for their family's health needs.

Three significant path differences were found when comparing younger (< 44 years old) to older respondents (45 +). First, younger consumers perceive a direct benefit from provider-created (B2C) digital information to TM usage ($\beta = 0.223$, $p < .010$, $z = 1.874$). Second,

Table 4
Tests of the SEM path hypotheses.

Hypotheses and Paths				Std. β Coefficient	t-value	p-value
Direct Paths to TM Usage Likelihood						
H1	External provider and consumer co-created	→	Usage likelihood	0.169	5.0	0.001
H2	Comparative service quality	→	Usage likelihood	0.360	5.7	0.001
H3	Access benefits	→	Usage likelihood	0.350	5.3	0.001
Indirect Paths						
H4	Provider-created	→	Comparative service quality	0.188	3.0	0.001
H5	External provider and consumer co-created	→	Comparative service quality	−0.143	−2.0	0.050
H6	Consumer-created	→	Comparative service quality	0.335	4.2	0.001
H7	Provider-created	→	Access benefits	−0.009	−0.22	n.s.
H8	External provider and consumer co-created	→	Access benefits	−0.008	−0.20	n.s.
H9	Consumer-created	→	Access benefits	0.090	2.7	0.010
H10	Comparative service quality	→	Access benefits	0.804	15.8	0.001

Notes: $\chi 2 = 400$; d.f. = 185; GFI = 0.96; AGFI = 0.94; CFI = 0.98; NFI = 0.97; RMSEA = 0.036.
n.s. = not significant; d. f. = degrees of freedom; GFI = goodness of fit index; AGFI = adjusted goodness of fit index; CFI = comparative fit index; NFI = normed fit index; RMSEA = root mean square error of approximation.

provider-created (B2C) digital to comparative benefits is significant only for older consumers ($\beta = 0.185$, $p < .001$, $z = 2.105$). Finally, comparative benefits to TM usage ($\beta = 0.826$, $p < .000$, $z = 1.838$) was only significant for older consumers. The results suggest younger consumers may already have positive perceptions that TM is useful, whereas older consumers need to first be convinced of the comparative benefits to increase their usage likelihood and health providers may be able to do so via their controlled digital presence.

6. Discussion

Service-altering innovations, in this case TM, have the ability to dramatically alter service ecosystems via their impact on customers, competitors, and service delivery processes (Chandler et al., 2019). There is a growing consensus that service ecosystems contain an array of interdependent roles, participants, and relationship-building processes (Helkkula et al., 2018). Consistent with SDL, value for a service innovation is co-created through an integrative process that incorporates the viewpoints of all actors in a service ecosystem (Vargo & Lusch, 2016). Regardless of platform and source, intra-system and interactor communication encounters play a crucial role in the value co-creation process (Breidbach & Brodie, 2017; Pera et al., 2016), and especially for value co-creation in multiplex healthcare service ecosystems (Razmdoost, Alinaghian, & Smyth, 2019).

6.1. Theoretical implications

Our study contributes to a growing stream of SDL research demonstrating the value of engaging consumers in co-creation activities across service ecosystems, and that information flows amongst ecosystem participants enhances value co-creation and can lead to service innovation adoption. Although different co-creation activities exist (Sweeney et al., 2015), we focus on resource integration in the form of provider and consumer-created digital information flows (Storbacka et al., 2016). We created a Digital Information Flow Continuum that differentiates the source of communications, and how these digital sources impact perceptions of two potential benefits of TM services – comparative service quality relative to alternatives and access to care. Our Digital Information Flow Continuum, identified three digital source platforms, primarily provider-created (B2C), external provider and consumer co-created (B2B/C2C combined) and primarily consumer-created (C2C).

Our findings contribute to the SDL and service ecosystem literature in a number of ways. First, we show that ecosystems are complex, integrative, and collaborative. Services research has generally considered customer engagement as dyadic interactions at the micro-level (Alexander et al., 2018). We thus contribute to the literature by examining multi-actor service ecosystems (Breidbach & Brodie, 2017; Li, Juric, & Brodie, 2017), and particularly through an increased understanding of the role that diverse digital information sources have on reducing information asymmetry to influence perceptions of service innovations and their adoption (Jang & Chung, 2014; Larivière et al., 2017). Importantly, our findings show that knowledge acquisition offers different routes to value co-creation for service innovations.

We utilize SDL to lay the foundation of value co-creation in the context of service innovations in general, and TM specifically. TM co-creates value for consumers via how health service needs are understood, communicated, and resolved by requiring consumers and providers to co-produce outcomes before, during, and after service delivery (Swan et al., 2019). We thus extend SDL research investigating the use of digital information seeking in the co-creation of pro-health behaviors (Dahl et al., 2018). In line with SDL, our findings show TM usage likelihood is predicated on consumers' perceptions of how value is co-created through this new health service delivery, and specifically with regard to comparable service delivery quality to their incumbent care, and at a time and place of their choice. There is thus a temporal nature to the adoption of service innovations (Razmdoost et al., 2019). Our findings align with the innovation literature, showing that perceived usefulness and ease of access are precursors for the acceptance of service innovation (Christensen et al., 2015; Davis, 1989).

Lastly, our Digital Information Flow Continuum offers new insights on how the ever-growing use of online communication platforms impacts the acceptance of service innovations. We examined both the direct effects of digital information flow platforms on service innovation adoption, and indirectly through perceptions of comparative service quality relative to alternatives and ease of access to care. The findings offer some unique insights. First, all three of our digital information flow sources, directly (B2C/C2C combined) or indirectly (through comparative service quality relative to alternatives and access benefits) impacted usage likelihood. However, as hypothesized, only external provider and consumer co-created digital communications had a significant, direct effect on adoption likelihood (note: direct paths for the other two were also examined and were not significant). Perhaps this relationship reflects the fact that well-branded websites such as WebMD and the Mayo Clinic offer an extensive array of credible health information, plus have well-established C2C communications platforms available, and thus contain competencies associated with each endpoint on the Digital Information Flow Continuum that enable co-creation. Moreover, digital marketing technologies, particularly externally created resources, offer a promising and unbiased tool for enabling consumers to close the information asymmetry gap and take control of decision making, such as when to seek professional medical care via TM.

The path results for the Digital Information Flow Continuum elements to comparative service quality relative to alternatives/access benefits highlight that service ecosystem actors have divergent communication effects. Surprisingly, while the combined direct and indirect effects of B2C/C2C co-created digital communications on usage likelihood is positive, its path to comparative health was negative. A possible explanation is that the externally-branded wellness websites typically offer more unbiased information about TM than a service provider promoting its TM services. This suggests a complex relationship may exist in terms of digital information flows, information asymmetry, and the acceptance of service innovations (Dahl et al., 2019).

6.2. Practical implications

We extend the service ecosystem literature by finding evidence that marketing communications created and distributed by different actors are important for the acceptance of service innovations (Razmdoost et al., 2019). The launch and commercialization of service innovations by providers do not exist in a communication vacuum. Rather, these exist in conjunction with communications from other firms and individuals who have a vested interest in that innovation (Kim & Baker, 2017). Recognizing what is being digitally created and shared from external parties is thus an important environmental scanning activity for service providers. Especially important, firms need to understand and influence how digital communications from varied actors positively impact relative competencies of their service innovation, and how these competencies may complement or supplement incumbent offerings. Lastly, our findings show that comparative service quality is a key construct in our model. Comparative service quality was most strongly associated with TM usage likelihood, was impacted by all three digital information flows, and had a strong influence on perceptions of access benefits associated with TM.

From a public policy perspective, health consumers are often at a knowledge disadvantage compared with service providers; yet policymakers and researchers increasingly advocate for greater patient accountability and empowerment in decision making. Research that examines how the coproduction process unfolds and the role of marketing technologies in this process is scarce. To our knowledge, we are the first

to empirically explore the coproduction process and the roles of different marketing communication flows on the acceptance of TM. The cost of health care is continuing to skyrocket. TM offers a means by which consumer and ecosystem costs may be positively impacted through increased implementation of digital health services.

6.3. Limitations and future research

Although our study contributes to the literature in a number of ways, it has limitations. First, Digital Information Flow Continuum elements were operationalized using sources within a healthcare context. Decision criteria and information needs may differ in other service industries like mobile banking, insurance, investing, etc. Research is needed that investigates an array of digital information flow types in different service contexts (Payne et al., 2018). Second, because the adoption of TM is limited to date, we utilized future usage likelihood rather than actual behavioral data as our dependent measure. We encourage research that examines digital information flows across different stages of the diffusion and adoption process. Moreover, while we argued that consumers would seek out external digital information to reduce information asymmetry related to service innovations, we did not address the full range of sources and solutions for closing knowledge gaps. We thus encourage future research that seeks to better understand the causes and resolutions for information asymmetry. Third, our research utilized parsimonious measures for each of our three different digital informational flow sources. However, a broader array of specific digital information exemplars exists for each of these communication sources. For example, C2C communications using social media may take the form of written communications, photos, videos, messaging, URLs, etc. Understanding how these more specific information formats impact perceptions and usage of service innovations would extend the literature. Fourth, our study focused on a single service innovation. Research assessing how digital information flow sources impact the awareness, acceptance, and adoption of all types, from incremental to disruptive, is warranted. Fifth, we only focused on a small set of possible TM benefits and tested a limited set of structural relationships. Future research is needed to expand this set and to further develop the comparable service quality and access benefits used in this study and to see whether different conceptualizations reverse directional effects. Lastly, the sample used the primary service area of a healthcare system that may not be representative of more diverse, urban settings. Research that extends this model to different settings may therefore be of value.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

None.

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