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Privacy paradox in 3D body scanning technology: the effect of 3D virtual try-on experience in the relationship between privacy concerns and mobile app adoption intention

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3D body scanning technology has emerged in the retail industry by providing easy access to consumers. The technology has been incorporated with virtual-try-on (VTO) services to capture the accurate size of the human body and to provide user-centric experiences to online consumers. While consumers can have their body images scanned and shared with retailers, it raises concerns related to body information security and privacy. With the concern implied, the purpose of this study is to understand the role of consumers' interaction experience with Avatar-based VTO services in alleviating consumer concerns related to body information privacy to adopt 3D body scanning technology. By adopting the privacy calculus theory and stimulus-organism-response model, the dataset ($n = 285$) was collected from an online experiment. The direct and indirect paths (i.e., mediation and serial mediation effects) were analyzed by adopting the partial least squares structural equation modeling (PLS-SEM) approach. This study finds body information privacy concerns negatively influence the future adoption of 3D body scanning technology while the perception of interactive features (i.e., perceived control, perceived responsiveness) of the VTO service positively enhances the future adoption. The result also indicates that the negative effects of privacy concerns can be mitigated through consumer experiences enhanced by the personalization and responsiveness features of the VTO service. This study contributes to the literature and industry by examining the potential role of consumers' interactive experiences in reducing their concerns about body information privacy.

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Introduction

Three-dimensional (3D) body scanning technology refers to a multi-dimensional measurement system that captures body images to produce accurate 3D models of the human body (Lu and Hahn, 2019). These digitized 3D images have been used in the mass customization of apparel, and consumers can choose a garment with a style that matches their choices through the personally created avatars seen on the computer screen (Lu and Hahn, 2019). In the early stage of 3D body scanning technology's commercialization, retailers adopted it to provide customized services in their stores and used it to identify garments that suit the individual customer's unique body shape and size (Bodymetrics, 2012; Govisetech, 2021; Smith et al. 2022). For example, Bloomingdales launched the "Body-Sizing Pod" in their store in 2012 that allowed shoppers to find jeans quickly that fit their body size and shape perfectly (Govisetech, 2021). Further, New Look, one of the UK's largest fashion retailers, launched the PrimeSense technology in the global Westfield Stratford shopping complex (Bodymetrics, 2012).

In contrast to the early adoption, 3D body scanning technology has become even more accessible to consumers recently, as the technology has reached a level such that it takes only a few seconds from scanning a human body and capturing the size to creating true-to-scale 3D models (Govisetech, 2021). Lots of innovative software providers (e.g., Fit3D, StyKu) have made the technology accessible to consumers (Lu and Hahn, 2019). Virtual shoppers can scan their bodies at home with affordable and portable 3D technologies through mobile apps (Lu and Hahn, 2019; Smith et al., 2022). As the development of technology has paved the way for mass consumers' use, in 2019 Chip Bergh, Levi Strauss CEO, stated that "Sizes will go out the window 10 years from now. Everyone can do their own body scan on a camera" (Scripps National, 2019). According to Bergh, consumers will have their own avatars, as they will be able to scan their bodies with an accessible mobile device that will measure them at 365 degrees to create a truly accurate 3D image. In addition to this, Amazon, a leading online retailer adopted 3D body scanning technology. After launching private apparel labels, they acquired Body Labs, a software provider, to measure online consumers' 3D body shape and motion from multiple photos through the technology in 2019 (Govisetech, 2021).

Despite the availability and easy access to 3D body scanning technology, Bindahman et al. (2012) argued that without understanding consumers' privacy concerns related to the technology, retailers cannot integrate it into virtual try-on (VTO) services successfully (Lu and Hahn, 2019; Bindahman et al., 2012). Body information security risk refers to individuals' concerns about their inability to control the collection and use of personal information that is recorded in the information system (Bindahman et al. 2012). This represents a great barrier for practitioners with respect to ways to keep all personal body information secure and private (Bindahman et al., 2012; Kim and Labat, 2013). Although computer scientists have suggested various encryption processes and privacy algorithms to encode information to protect private body information, having their body images scanned and sharing detailed body measurements with retailers remains a serious concern for consumers (Bindahman et al., 2012). Only a small number of scholars have identified consumers' privacy concerns related to the mobile 3D body scanning technology for customized digital services (Almousa, 2020).

To close the gap, this study attempts to understand online consumers' adoption of the mobile 3D body scanning technology for the following reasons. First, although the privacy concern is implied, scholarly and industry professionals expect that VTO services integrated with 3D body scanning technology will be an emerging leading technology among online service sectors targeting personalized demands (Govisetech, 2021; Lin and Kang, 2019). Indeed, it is timely and necessary to understand the negative effect of consumers' body information privacy concerns on their future intention to adopt mobile 3D body scanning technology. Second, VTO services provide consumers with various interactive service experiences—i.e., perceived control, personalization, and responsiveness—while creating 3D models and trying virtual products on the avatar (Kim and Forsythe, 2008; Lee et al., 2020). While product recommendation services that require body measurements (i.e., height, weight, body shape) is widely available online, it remains unclear how the Avatar-based VTO service would potentially connect consumers' interactive experiences to their future adoption of the invasive technology of 3D body scanning with regards to privacy concern. Therefore, to understand the future integration of the Avatar-based VTO services with 3D body scanning technology through mobile phones, it is necessary to (a) explore the influence of consumers' actual experience with the VTO service on the future intention to adopt the 3D body scanning technology and to (b) examine how the experience eventually mitigates the negative effect of privacy concerns on future adoption. Ultimately, this study attempts to explore the role of consumer experience enhanced with integrative features of VTO services (i.e., control, personalization, and responsiveness) in increasing their future adoption while potentially compromising consumers' body information privacy.

Literature review

Virtual try-on (VTO) service in fashion e-commerce. VTO service refers to the service technology that provides a virtual interface in which consumers examine a product that provides information similar to that obtained from examining the product directly (Kim and Forsythe, 2008). VTO services provide various services, including photo-based, Avatar-based, and Augmented Reality (AR)-based. Photo-based VTO services allow consumers to upload their one-dimensional photos (e.g., either a saved or captured photo) and try on products on the photo virtually (Feng and Xiem, 2019). Avatar-based VTO services provide an online interface where consumers provide their body measurements (i.e., height, weight, body shape) to personalize the avatar with their own body appearance (Kim and Forsythe, 2008). AR-based VTO services refer to real-time-based services that superimpose virtual elements directly into the real environment through a screen (Yim and Park, 2019).

Among VTO services available currently, photo-based services have been commercialized widely and studied for non-garment items (i.e., sunglasses, earrings) that do not need to be sized to obtain an accurate fit (Zhang et al., 2019). Feng and Xie (2019) explained that the photo-based service uses image rendering technology (i.e., try on sunglass or accessories virtually on one's own photo); however, it is difficult for users to assess apparel items for accurate fit (Feng and Xie, 2019; Plotkina and Saurel, 2019). Other scholars focused on photo-based VTO services, where users posted their one-dimensional photos and try-on digital garments through the image rendering process (Ivanov et al., 2022a; Lee et al., 2020). They found that the photo-based VTO service increased immersive experiences (i.e., Lee et al., 2020). Even though it increases user experience and provides various try-on attempts (i.e., mix and match), for apparel product shopping, size issues remain unclear because it is challenging to assess accurate fit (e.g., Feng and Xie, 2019).

In a similar vein, many studies on AR-based VTO services have focused on immersive consumer experiences with fashion products that do not need to provide an accurate size, such as watches, sunglasses, shoes, and beauty products (Yim and Park, 2019). Plotkina and Saurel (2019) suggested that when compared to the AR-based VTO service, the human model-based VTO services provide better service experiences to consumers when they are shopping for apparel products (i.e., women's dresses) online. Their results showed that participants who experienced personalized 3D models (i.e., body size and ethnicity) in the online platform perceived that they were more useful for examining the apparel product when compared to VR-based services (Plokina and Saurel, 2019). Indeed, AR-based VTO services have been developed with a technology that transfers body information data into real-time movement through a virtual mirror so that consumers can try on apparel immediately by watching the mirror (Liu et al., 2020). Thus, the AR-based VTO service has been adopted for promotion purposes in physical store settings as it is less convenient for online apparel consumers in the non-store setting.

Considering the challenges of VTO services for online apparel shopping, it has been suggested that VTO service based on personalized Avatars is particularly useful online (e.g., Kim and Forsythe, 2008; Huan and Qin, 2011). For example, Merle et al., (2012) examined the influence of body perception (i.e., body esteem) on the user experience of the Avatar-based VTO services (i.e., confidence in apparel fit and shopping values). They compared four types of VTO conditions—i.e., mix-and-match condition (i.e., zoom-in/out and compare different outfits), non-personalized condition (i.e., generic female model), personalized condition (i.e., height and weight), and highly personalized condition (i.e., added actual face photo; Merle et al. 2012). They found that compared to the control condition (i.e., mix-and-match), VTO shopping conditions did not enhance shopping experiences. However, when compared to non-personalized conditions, consumers perceived greater utilitarian values in the personalized VTO condition. They also found that consumers' body perception positively influenced VTO self-congruent and confidence in apparel fit. More recently, Lee et al. (2020) focused on an Avatar-based VTO service (i.e., mobile app) and found that the service provides immersive experiences and interactive experiences (i.e., Ivanov et al., 2022a).

3D body scanning and mobile 3D scanning technologies. 3D body scanning technology refers to technology that scans the human body, extracts a large number of body measurement data, and produces a 3D avatar (Liu et al., 2017). The technology has been adopted in the retail industry, but compared to other industries, the 3D avatar's dimensions must match the real human body as much as possible for dynamic fit evaluations with body movement to achieve good experiences with VTO services (Liu et al., 2017). Many previous researchers have suggested that the technology may be the solution to such difficulties as the variety of consumer demands for accurate fit and size, and the inability to examine apparel products while shopping online (Liu et al., 2017; Sohn et al., 2020). They also suggested that the virtual service developed from accurate body information obtained from the real human body reduces the cost incurred in manufacturing and selling a garment (Sohn et al., 2020).

Regarding the technology, previous studies have shown the possibility of incorporating the Avatar-based VTO service into 3D body scanning technology. For example, Liu et al. (2017) explained that to try on the garment, avatars created with 3D body scanning technologies (e.g., parametric modeling method) must contain accurate body information for different parts, including the hands, feet, head, and torso. Sohn et al. (2020) indicated that retail services based upon avatars created by 3D body-scanning technology are particularly important to provide customized garments (i.e., jackets). Their results indicated that a garment developed with 3D body scanning technology increased customer satisfaction with the fit compared to their satisfaction purchasing ready-to-wear garments without the customized service.

Regarding mobile VTO services, recent scholars focused on VTO services that provide users with immersive and personalized mobile shopping experiences (Tawira and Ivanov, 2022; Lee et al., 2020). They examined mobile VTO apps (i.e., Zeekit and Forma) where consumers try-on digital garments in the one-dimensional photo shared. For example, Tawira and Ivanov (2022) suggested that Zeekit reported high perceptions of realism. While Zeekit provides more exploratory shopping (i.e., five different categories), Forma provides VTO shopping in realistic and goal-directed situations (Tawira and Ivanov, 2022).

Further, with mobile 3D body scanning technologies, it is possible to create a personalized 3D model (i.e., avatar) based on accurately guided taken photos of the front and side of a standing person (Xia et al., 2019). Xia et al. (2019) compared traditional 3D body scanners (i.e., stationary scanners) to mobile 3D handler scanners (i.e., Structure Sensor, Occipital). They attached the Structure Sensor to iPhone and moved it around the mannequin to capture all angles (front, back, and up/down). The mobile handler scanner is cost-efficient but collects body measurements with low reliability compared to stationary scanners (Xia et al., 2019). Unlike the hander scanner, currently available mobile scanning technologies (i.e., Me Three Sixty, MTailor, Meepl, I-Deal SizeYou) utilize a built-in smartphone camera to take photos (or a short video) of a user. It takes multiple angles of the body structure and builds a 3D avatar on the mobile phone (Pei, 2022). As they are technology companies, not retail companies, the integration of mobile 3D apps into online fashion retailers is expected to increase. In addition, a new scanning technology, LiDAR (Light Detection and Ranging), has been added to the cameras of iPhone 12 pros (Wilson, 2021). The new scanning feature is popular for experiencing immersive mobile games and interior design mobile try-on, offering potentially widespread implications of 3D body scanning technology in online commerce.

3D body scanning technology and body information privacy: privacy calculus perspective. Debates about privacy always arise when the public adopts a new technology and service (Cowan et al., 2021; Akhtar et al., 2022). According to the privacy calculus theory, privacy concern takes place when people adopt an invasive technology that requires them to share personal information (Pentina et al. 2016). The theory explains that consumers have a conflicting mindset (i.e., privacy paradox) where they perceive privacy concerns while expecting benefits from the technology (Smith et al., 1996). An extensive body of literature has ranged from biomarkers, drones, surveillance, social media, and location-based services to wearable technology (Li et al., 2016; Benlian et al., 2020; Zhu et al., 2021). Specifically, 3D body scanning technology is based on image modeling processing, and thus, not only body images shared but also a large amount of body measurements extracted from the 3D modeling process causes potential privacy issues (e.g., information breach; Pei, 2022; Smith et al., 2022; Zhu et al., 2021). Indeed, VTO services based on 3D body scanning technology calculate and collect more detailed body measurement datasets beyond the few measurement options (i.e., weight, height, bust size, and skin color). Thus, the information privacy concern raised centers around the service from the perspective of privacy calculus theory.

Early scholarly attempts to study VTO services did not focus on the negative effect of consumer concerns related to personal body information breaches because the service was in the introductory stage of public adoption (Huang and Qin, 2011; Kim and Forsythe, 2008). Later, several researchers found that privacy concerns increased the perception of intrusiveness, in which consumers are required to share their body images (i.e., photorealistic avatar) with the VTO service provider (i.e., mobile photo-based VTO service app; Zhang et al., 2019; Ivanov et al., 2022b). Although many studies have focused on the Avatar-based service, discussion about consumers' responses toward potential integration of the VTO service with 3D body scanning technologies is omitted, especially regarding privacy concerns (e.g., Lin and Kang, 2019).

With respect to the 3D body scanning technology, there has been scholarly discussion about the technology and related body information privacy concerns. Early studies found that users were concerned about their privacy and the security of their body information, which is a barrier to public adoption of the technology (Kim and Labat, 2013). Other research indicated that female consumers (i.e., Saudi Arabian females) who used a 3D body scanning service to shop for apparel expressed their concerns related to personal body information breaches regardless of their satisfaction with the clothing's fit (Almousa, 2020). Lee et al. (2020) also noted that consumers are required to share their own body images with a service provider to use VTO services (i.e., one-dimensional photo-based mobile VTO services; Zeekit). Even though the VTO service did not build an Avatar based on a 360-degree modeling process (i.e., front try-on image is only available; Lee et al., 2020; Zhang et al., 2019), scholars mentioned that consumers' privacy concerns would increase when posting their photo (Zhang et al., 2019). Given the great potential of 3D body scanning technologies incorporated into Avatar-based VTO with a 3D modeling process (Lin and Kang, 2019), it is timely to understand the effects of body information privacy concerns on future adoption of the VTO service that incorporates 3D body scanning technology, and the way to reduce its negative effects on future adoption.

Avatar-based VTO experience in stimuli-organism-response model. The S-O-R model originated in psychology and explains that environmental stimuli (i.e., interactivities of the service itself) (S) influence peoples' internal state (i.e., considering consumers as an organism) (O), which in turn explains their behavioral response (R) (Russell and Mehrabian, 1974). The S-O-R framework provides an applicable theoretical lens to understand the way that various interactive features (e.g., perceived control, personalization, and responsiveness) of the media stimuli in VTO services can enhance consumers' experiences. Even though a recent study suggests distinctive characteristics (i.e., augmentation) of Avatar-based VTO services (Lee et al., 2020), it has not been identified how distinctive interactivity-related features take a role in understanding consumers' experiences and their adoption of the new service incorporated with a 3D body scanning technology. Therefore, the current study suggests that the S-O-R framework will provide practical applications to understand the relations among the interactivities of the service (S), consumers' experience (O), and future adoption of 3D body scanning technology in VTO services (R), in which body information privacy concerns are considered for understanding the future adoption.

Perceived interactivity. According to the model of interactivity (Rafaeli and Sudweeks, 1997), perceived interactivity has been conceptualized as the audience's perceptions of the features in an interactive system (i.e., website), including perceptions of two-way communication, level of control, activity, sense, and time sensitivity. According to users' perspective, perceived interactivity refers to psychological perceptions while interacting with a web interface where computer-mediated communication occurs (Wu and Wu, 2006). The perception of interactivity consists of distinct dimensions: (1) control; (2) responsiveness, and (3) personalization (Wu and Wu, 2006). Perceived control is identified as "… the perceived ease or difficulty of performing the behavior" (Ajzen, 1988, p. 132). As websites are places where consumer activities occur, such as navigating over the site, searching content, and modifying the pace of their visit to the website (Hoffman and Novak, 1996), consumers obtain a sense of confidence about their behavioral control over the process of interaction. Perceived responsiveness refers to the way website users perceive the interactive system that responds timely to their input (e.g., navigation cues) (Wu and Wu, 2006). Consumers perceive that VTO services are responsive when they experience real-time feedback when they click on a navigation button (Kim and Forsythe, 2008). Perceived personalization refers to a belief that received responses are appropriate and personally relevant to personal needs on the website (Davis, 1982). In the context of dyadic interaction between a customer and service provider, a higher level of VTO services' personalization increases service quality and customer satisfaction (Jin et al., 2020; Lin and Kang, 2019).

Customer experience. In addition to perceived interactivity as stimulation in VTO services (S), organism responses (O) of consumer experiences refers to a holistic expression of experiences achieved from interaction with stimuli (i.e., shopping environment) that accompany diverse service touchpoints (Ramaseshan and Stein, 2014). As consumer experience is based upon experiential attributes, previous researchers have identified its various sub-dimensions (Brakus et al., 2009; Schmitt et al., 2015). For example, Brakus et al. (2009) found that consumer experience can be conceptualized according to sub-dimensions—i.e., sensory, affective, and intellectual. The sensory experience is related to tangible, visual, or audio touchpoints; feelings, emotions, and sentimental stimuli convey the affective dimension; stimuli that trigger productive thoughts and curiosity are identified as the intellectual experience, while the behavioral dimension indicates consumers' interactions with the company, such as sharing opinions with others or re-visiting the store or service (Schmitt et al., 2015). Although it has distinct dimensions, consumer experience occurs holistically when exposed to company-related simulation (i.e., service), where the experience's intensity depends upon how experiential dimensions are evoked strongly (Schmitt et al., 2015).

Privacy calculus and the S-O-R approach for understanding negative effects of privacy concern. From the perspective of privacy calculus theory, this study suggests that consumers' positive VTO experiences will compromise privacy concerns (e.g., Pentina et al., 2016; Smith et al., 1996). Thus, we suggest the negative effect of body information privacy concerns on future intentions to adopt the 3D body scanning technology can be alleviated through consumers' enhanced experience with Avatar-based VTO services. Previous scholars have suggested the potential roles of the S-O-R model in understanding the effect of privacy concerns on future adoption of VTO services (e.g., Lee et al., 2010; Huang and Qin, 2011; Zhang et al., 2019). Previous scholars suggested that consumers' concerns about information privacy had direct effects on purchase intention within the S-O-R framework (Kim and Lennon, 2013). In the context of VTO services, other scholars identified that VTO users' (i.e., non-user vs. users) risk perceptions (i.e., privacy concern or shopping risk) have negative influence on their future adoption while favored

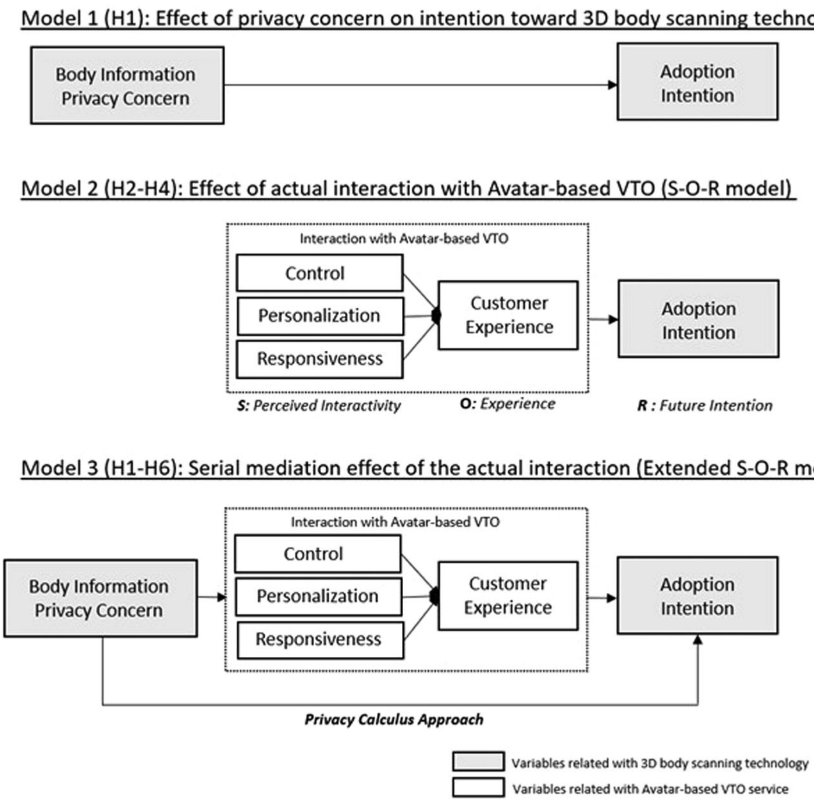

Fig. 1 Conceptual model. VTO virtual try-on, S-O-R model stimulus-organism-response model.

experiences (i.e., entertainment or usefulness) have positive effects on it (Lee et al., 2010; Huang and Qin, 2011; Zhang et al., 2019). Although lots of previous scholars adopted the S-O-R to examine the effect of privacy concerns within the theory, their implication focused on how to increase the VTO service adoption. Unlike previous scholars' approach, by incorporating the privacy calculus theory into the S-O-R framework, our study emphasizes the role of VTO services in mitigating privacy concerns and ultimately increasing the adoption of a new VTO service based on 3D body scanning technology. Indeed, there has been a lack of discussion of how the S-O-R takes a role in mitigating the pre-existing privacy concerns toward body measurements from the perspective of privacy calculus. Especially given the fact that body information-related concerns become a great barrier to future integration of the VTO service into 3D body-scanning technology (Lu and Hahn, 2019; Benlian et al., 2020), we believe that the extended S-O-R model within the theoretical lens of privacy calculus explains how enhanced consumer experiences through interactive features of VTO services would mitigate negative effects of the privacy concern.

Based on insights from the previous empirical research on privacy concerns toward 3D body scanning technology (i.e., privacy calculus perspective) and consumers' interactive experiences with VTO services (i.e., S-O-R perspective), this study attempts to empirically examine the role of S-O-R model in alleviating consumers' concerns toward their body information privacy related with 3D body scanning technology. Therefore, first, this study examines the influence of body information privacy concerns on future intention to adopt the 3D body scanning technology (Model 1). Then, the research model that included interactivity (S), consumer experience (O), and future behavioral intention (R) is examined (Model 2). Finally, the role of interactive experiences with Avatar-based VTO services (i.e., customer experience followed by perceived interactivities) in mitigating the negative effect of privacy concerns on future intention is examined (Model 3). The conceptual research model is presented in Fig. 1.

Hypothesis development

Effects of body information privacy concern on adoption intention. Huang and Qin (2011) found a direct negative relation between perceived risk attributable to privacy concerns and consumers' intention to use virtual fitting room services. According to Feng and Xie (2019), VTO technology users with strong privacy concerns are likely to perceive greater intrusiveness about their self-viewing (viewing that they are wearing the product). This is because users with a higher level of privacy concerns consider that self-viewing poses a threat to their privacy. They asserted that their privacy-related intrusive perception influenced their attitudes toward adopting VTO services negatively. Moreover, with respect to VTO technology that uses 3D scanning technology for mobile apps, Sekhavat and Nomani (2017) suggested that implied personalization (i.e., realistic image) needs to address users' privacy concerns to encourage their acceptance. These indicated the critical role of privacy concerns in consumers' adoption of the new customized VTO services. Thus, we suggest the following hypotheses.

H1: Body information privacy concerns will influence the adoption intention of 3D body scanning technology in VTO services negatively.

Effects of perceived interactivity on consumer experience. Consumer experience can be enhanced through marketing or service tools online (Farah et al., 2019; Lee and Youn, 2020). Lee and Youn (2020) found that consumer experience was composed of sensory, affective, and intellectual responses to the interactive service tools, and suggested that an environmental cue in the interactive media (i.e., videos) influenced consumers' experience. Farah et al. (2019) suggested that the perception of interactivity enhances consumer experiences overall and satisfies expectations of interactive virtual services within the online shopping context. In the case of multi-sensory interactive tools in VTO services, such services provide a 3D model constructed with consumers' input, where they can control and personalize the outfit of a model (Huang and Qin, 2011). Therefore, the following hypotheses were proposed.

H2: Perceived interactivity— (1) control, (2) personalization, and (3) responsiveness—will increase consumers' experiences with the Avatar-based VTO service.

Future intention (R) to adopt 3D body scanning technology in VTO service. Previous studies have discussed consumers' service experiences and their effect on their intention to use or adopt a service. In the case of VTO services, Lee et al. (2020) found that their interactive aspects influence consumers' immersive service experience directly and positively. Chen et al. (2008) examined the effect of the virtual marketing service experience on consumers' intention to browse a site and purchase a product. They presented five virtual marketing service elements (i.e., sense, interaction, pleasure, flow, and relation), and pointed out that sensory or affective aspects of consumers' experience are the core factor that shapes their shopping and service preferences. As 3D body scanning technology offers consumers a more customized experience and enhances their satisfaction with garment fit (Sohn et al., 2020), consumers who experience interactive Avatar-based VTO services will be more motivated to adopt VTO services that incorporate 3D body scanning. Thus, the following hypotheses were proposed.

H3: Consumers' perceived experience with the Avatar-based VTO service will increase the adoption intention of 3D body scanning technology in VTO services.

Mediation role of consumer experience with VTO service. Jin et al. (2020) asserted that an immersive consumer online shopping experience that interactive platforms provide promoted users' continuous use. They highlighted the mediating role of immersive experience between the features of the information platform and the continued motivation to use the platform within the S-O-R framework. Huang (2017) applied the S-O-R framework and investigated the internal experience (i.e., emotional aspect) as a mediator that connects web atmospherics/mobile characteristics and consumers' intention to purchase in the mobile commerce market. Consumers' emotional and cognitive experiences of a new technology-based service were also found empirically to influence their intention to use the service (Koufaris, 2002). Moreover, particularly for apparel products, the greatest willingness to use 3D body scanning was found in a product development service, as fit and silhouette were the most salient factors in consumers' purchase decisions (Lee et al., 2010). As the Avatar-based VTO services provide various interactive touch points for their users (Lee et al., 2020), we suggest that an enhanced consumer experience will mediate the effect of the VTO services' interactive features on the future adoption of the 3D body scanning technology in VTO services.

H4: Consumers' experience with the Avatar-based VTO service will mediate the effect of the service's perceived interactivity— (1) control, (2) personalization, and (3) responsiveness—positively in the adoption intention of 3D body scanning technology in VTO services.

Effects of body information privacy concerns on perceived inveracity. Zhang et al. (2019) suggested that VTO service providers must consider perceived privacy risk (i.e., body information) and the negative influence on consumers' attitudes toward VTO technology. With respect to privacy risks, Chellappa and Sin (2005) pointed out that privacy concerns affect online consumers' perceived personalization negatively. As web-based personalization services require acquiring valuable private information from customers, consumers' negative perception toward personalization services was found. Wu et al. (2010) also found a negative relation between perceived web assurance related to online shopping concerns (e.g., privacy, security, and/or reliability) and consumers' perceived interactivity (i.e., perceived control, responsiveness, and personalization). Thus, we suggest the following hypotheses.

H5: Body information privacy concerns will influence the perceived interactivity—(1) control, (2) personalization, and (3) responsiveness—of the Avatar-based VTO service negatively.

Perceived interactivity and consumer experience as mediators in reducing body information privacy concern. Although several previous scholars have identified the negative effects of body information privacy concerns on consumers' perceptions and behavior in the VTO service context (Huang and Qin, 2011; Zhang et al., 2019), enhanced consumer experiences attributable to the service's interactive features can mitigate the negative effect of their concerns on their future adoption serially. Previous scholars have suggested the potential of the mediating roles of interactive service features and consumer experience to increase the intention to make decisions in various contexts. For example, Koufaris (2002) found that the perceived interactivity of a service technology influenced consumers' willingness to use the service mediated through their emotional and cognitive experience. In online service settings, Nel and Boshoff (2019) investigated the indirect relation between online and mobile service use through consumers' internalized experience (i.e., online service inertia). They also found that consumers' experiential value and satisfaction mediated interactivity's effect on their future behavioral intention to browse the website. From the other perspective of risk perception, scholars have suggested the mediating role of negative perceptions in the negative effect of privacy concerns on future behaviors. Yang (2014) found that privacy information concerns led to negative perceptions of the online service (i.e., lack of trust), which consequently explained negative behaviors (i.e., not disclosing information). Abbey et al. (2017) indicated that when consumers perceived the risk of functionally defective services, their negative perceptions mediated the negative effect of risk perceptions on future intention. These results indicated that the negative effect of consumers' concern on future behaviors could be alleviated if consumers' perceptions of the service were enhanced. Because consumers' perception of the interactive features of Avatar-based services enhances their experiences (Lee et al., 2020), the negative effect of their concerns (i.e., body information privacy) will be mitigated through positive perceptions of interactivity (S) followed by enhanced consumer experience (O).

H6: Perceived interactivity—(1) control, (2) personalization, and (3) responsiveness—followed by consumer experience will reduce the negative effect of body information privacy concerns on the adoption intention of 3D body scanning technology in VTO services.

Methodology

Online experiment of interactive VTO service. An online experiment design was developed. To provide an interactive VTO service experience, we adopted a currently available VTO service, style.me (Appendix A). While previous studies adopted Zeekit which provides VTO services based on uploaded one-dimensional photos through an image rendering process (Lee et al., 2020; Ivanov et al., 2022a), our study adopted style.me to provide users with experiences in building their own avatar based on body measurements to try-on digitalized garments by 360-degree rotating of the avatar. Lee et al. (2020) focused on immersive experiences with virtual try-on garments because users can see digital clothing along with their actual photo (i.e., Zeekit). However, previous scholars mentioned that fit issues had challenged photo-based VTO services due to a lack of accuracy of avatar size calculated from the one-dimensional photo rendering process (Feng and Xie, 2019; Plotkina and Saurel, 2019). Thus, our study adopted style.me to examine interactive experiences with the avatar that has a similar body size (i.e., 3D modeling process) and ultimately to see how this experience alleviates their privacy concerns when adopting 3D body scanning-based VTO services. Further, in our study context, style.me expands its service to mobile-based 3D body scanning technology. While traditional 3D body scanners deploy multiple-beam of lights through the sensors, where multiple images are captured and combined to build a 3D model, mobile scanning technology develops an accurate 3D model based on body measurements from two different positions (i.e., front and side images) through AI-based calculations (i.e., Me Three Sixty; Smith et al., 2022; Appendix B).

The online experiment includes three parts. In the first part, to provide actual service experiences of Avatar-based VTO online, we used a demo version of VTO service, style.me (Appendix A). In the experiment, to avoid distorting consumers' experiences due to the garment design, a gray jacket was selected. Participants were provided a situation in which they were looking for a plaid jacket and found one online. Then, following the instructions, participants clicked on the VTO service link and were asked to create an avatar with their body information, such as height, weight, bra size, and body shape (i.e., five options). Participants were instructed to try the jacket on the personalized avatar by changing the product's size following the fit and size recommendations and rotating the avatar (Appendix A). To confirm their actual service experience, we asked them to capture the final look and submit the image. In the second part, actual try-on experiences through interacting with the avatar were measured. To measure the interactivity, we adopted scales of perceived control ($\alpha = 0.92$), personalization ($\alpha = 0.93$), and responsiveness ($\alpha = 0.90$) from Wu and Wu (2006). The second-order concept of consumer experience was also measured with three sub-dimensions, sensory ($\alpha = 0.92$), affective ($\alpha = 0.89$), and intellectual ($\alpha = 0.95$) experiences (Manthiou et al., 2016). In the last part, participants were given a situation where the online retail company introduces a new VTO service based on 3D-body scanning technologies for creating an avatar of accurate body measurement. Instructions on how to 3D scan their body through mobile apps were provided (Segura, 2019; Appendix B). Then, they were asked about their intention to adopt the new VTO service on the avatar created on body information collected from 3D scanning technology (Kim and Forsythe, 2008). Body information privacy concerns ($\alpha = 0.90$; Roca et al., 2009) related to the technology were measured. It includes questions about users' concerns toward their personal body information collected from the retail company (e.g., I am concerned that too much of my personal body information will be collected from the 3D body scanning technology). Demographic questions were asked at the end. All questionnaires were measured on the 5-point Likert scale.

Data collection and participants. Regarding ethical considerations, we obtained approval to use human subjects from the Institutional Review Board (IRB). The developed online survey and VTO service did not collect any identifiable information (e.g., name, personal email, ID, or password). Thus, the risk of information breach within the experiment was minimum. Before collecting the data, the instruction was tested and improved to deliver user-friendly content of creating an avatar and trying on apparel items concisely, which avoids any confusion and makes participants feel comfortable. We made sure that the ethical consideration of future use of the collected data once again before participants provided their avatar images to confirm actual participation. The detailed process of the online experiment and survey was instructed in the approved informed consent. It was obtained from all participants at the bigging of the survey.

We conducted a pilot study with samples ($n = 32$) collected through Amazon Mechanical Turk (MTurk). Through the pilot study, we confirmed the instrument's validity for the online experiment. MTurk is a diverse workforce in which requesters can provide online tasks to individual workers. MTurk participants who hold an approval rating higher than 95% in over 1000 tasks were recruited for the online experiment to ensure the quality of the data. First, to maximize the response rate, we ensured the respondents' anonymity and confidentiality during the online experiment and survey (Schonlau and Toepoel, 2015). Also, to minimize non-response bias, we confirmed that the length of the online experiment and survey (i.e., no more than 30 min) is ideal and $1.5 is sufficient compensation for participants. Second, to ensure content validity, ambiguous or difficult questions were adjusted by a research method professional. For example, instructional information (i.e., how to build your own avatar) for the online experiment included six steps, which was adjusted to four steps with clear explanation. Finally, possible common method errors were examined by adopting statistical remedies. These include a single factor test (Harman, 1967) and controlling for the effects of unmeasured latent methods factors, which generated acceptable results (i.e., the ratio of variance is less than 50%). With all efforts and adjustments, we confirmed that common method bias is not a critical issue in our study.

For the main data collection, responses were collected through MTurk. To ensure our data's quality, we collected responses from MTurk workers who hold an approval rating greater than 97% in over 1000 tasks. After excluding incomplete responses and those that took an unreasonably short or long time (e.g., less than 10 minutes or more than 1 hour), 285 female participants' responses were used in the final analysis with a compensation rate of $1.5. As planned, all participants were provided a shopping situation where they followed an instruction to create an avatar. In the given situation, the retailer provides an Avatar-based VTO service and expands the service to mobile VTO services based on 3D body scanning technologies. Within the given situation, participants experienced interacting with their avatar and completed a survey to measure their experiences.

Regarding demographic and general information (Table 1), most participants were Caucasian (76.5%), had a college-level education (71.2%), and purchased apparel products online (96.5%). More than half were 25–34 (35.4%) and 35–44 (29.5%) years of age. The age range consists of those of U.S. digital buyers (eMarketer, 2020). Further, more than half of the participants had a total household income of $25,000–$49,999 (27.4%) and $50,000–$74,000 (23.5%). All participants had no prior experience with Avatar-based VTO services and mobile apps for 3D body scanning.

Results

The partial least squares structural equation modeling (PLS-SEM) approach was employed using Smart PLS v. 3.3.3 for the following

Table 1 Demographic characteristics.

	n	%
Gender		
Female	285	100.0
Age		
18–29	72	25.2
30–39	102	35.8
40–49	57	20.0
50–59	29	10.2
60–69	23	8.1
Over 70	2	0.7
Race		
White	218	76.5
Hispanic	24	8.4
American Indian or Alaska Native	1	0.4
Black or African American	28	9.8
Asian	10	3.5
Do not wish to disclose	2	0.7
Others	2	0.7
Education		
High School or Equivalent	34	11.9
Some College	71	24.9
College Graduate (4year)	132	46.3
Advanced Degree (post-graduate)	46	16.1
Others	2	0.8
Income level		
less than $24,999	40	14.0
$25,000–$49,999	78	27.4
$50,000–$74,999	67	23.5
$75,000–$99,999	43	15.1
$100,000–$149,999	42	14.7
$150,000–$199,999	9	3.2
$200,000 or more	6	2.1
Expenditure on fashion products (last year)		
None	6	2.1
Less than $100	48	16.8
$101–$200	58	20.4
$201–$500	69	24.2
$501–$1000	53	18.6
$1001–$2000	35	12.3
$2001–$3000	8	2.8
$3001–$4000	4	1.4
$4001 or more	4	1.5

reasons. First, PLS-SEM is a preferred method as it provides a more reliable estimation of a complex model that includes a reflective second-order construct with many measurement items (Hair et al., 2017). Second, it provides a practical approach to identify causal-predictive outcomes with the potential to explore all casual relations simultaneously within a theoretically developed framework (Hair et al., 2017). Therefore, this study examined the effect of body information privacy concerns on future intention to adopt the technology for online shopping (Model 1), in which the role of actual interaction with Avatar-based VTO services was examined in alleviating the effect of privacy concern on adoption intention toward the technology (Model 2 and Model 3).

Measurement model. To evaluate the measurement model, reliability and convergent and discriminant validity were assessed (Hair et al., 2017). All item loadings exceeded the recommended value of 0.60, the construct CR values were greater than 0.70, and the AVE values exceeded the threshold value of 0.50 (Hair et al., 2017), all of which confirmed reliability and convergent validity (Table 2). The Fornell-Larcker criterion ratio of correction technique was performed (Fornell and Larcker, 1981). This criterion showed that the square root of the AVE was higher than the correlated values (Table 2), which indicated that the model and all constructs had a satisfactory level of discriminant validity. We also examined the heterotrait-monotrait ratio (HTMT), which is a reliable contemporary approach to examine discriminant validity (Henseler and Sarstedt, 2013). The HTMT ratio showed that no values exceeded the threshold value of 0.90. These results confirmed the reliability and validity of the measures and constructs used in the model.

Structural Model Results. To test the model fit, the standardized root mean square residual (SRMR) and normed fit index (NFI) were examined as goodness-of-fit measures for PLS-SEM (Hair et al., 2017). For a model with indicators, the model indicates values of SRMR less than 0.08 and NFI greater than 0.90 (Henseler and Sarstedt, 2013). As the model showed SRMR = 0.07 and NFI = 0.90, its goodness-of-fit was confirmed. The variance the model explains (R^2) is a key criterion used to evaluate the quality of a proposal structural model in PLS-SEM, where it should be ranged from 0.25 to 0.65 for behavioral research (Hair et al., 2017). The R^2 values for the dependent variables ranged from 26 to 62% for models 1, 2, and 3 (Table 3).

Finally, the bootstrapping method was used to estimate the path coefficients (Table 3). The results of model 1 shows that the effect of body information privacy concern on future intention to adopt 3D body-scanning technology for VTO services were negatively significant (H1: $\beta = -0.265$, $p < 0.001$). Thus, H1 was accepted in model 1. In addition, the results of model 2 demonstrated that perceived control (H2a: $\beta = 0.129$, $p < 0.05$), personalization (H2b: $\beta = 0.569$, $p < 0.001$), and responsiveness (H2c: $\beta = 0.162$, $p < 0.01$), respectively, had positive effects on consumers' experience. Consumer experience (H3: $\beta = 0.684$, $p < 0.001$) influenced future intention to adopt 3D body-scanning technology for the VTO service positively. Further, consumer experiences mediated the effect of perceived control (H4a: $\beta = 0.088$, $p < 0.05$), personalization (H4b: $\beta = 0.389$ $p < 0.001$), and responsiveness (H4c: $\beta = 0.111$, $p < 0.01$) on adoption intention positively. Thus, H2-H4 were accepted in model 2.

Regarding results of model 3 (Fig. 2), it supported H1-H4 (H1: $\beta = -0.163$, $p < 0.01$; H2a: $\beta = 0.130$, $p < 0.05$; H2b: $\beta = 0.569$, $p < 0.05$; H2c: $\beta = 0.162$, $p < 0.05$; H3: $\beta = 0.651$, $p < 0.05$; H4a: $\beta = 0.084$, $p < 0.05$; H4b: $\beta = 0.370$, $p < 0.001$; H4c: $\beta = 0.106$, $p < 0.01$). In addition, the result demonstrated that body information privacy concern had a negative effect on perceived control (H5a: $\beta = -0.219$, $p < 0.001$) and responsiveness (H5c: $\beta = -0.207$, $p < 0.001$), while there was no effect on perceived personalization (H5b: $\beta = -0.109$, $t = 1.891$). Importantly, with respect to serial mediation effects, consumer experience followed by perceived control mediated the negative effect of body information privacy concern on adoption intention (H6a: $\beta = -0.018$, $p < 0.05$). However, importantly, consumer experience influenced by perceived personalization (H6b: $\beta = -0.004$, $t = 1.729$) and perceived responsiveness (H6c: $\beta = -0.002$, $t = 1.740$) did not mediate the negative effect on adoption intention. Thus, H6 was partially accepted.

Discussion

The study is motivated to advance our understanding of the distinctive effects of perceptions toward interactive VTO services to clarify the debate on whether and how enhanced consumer experience contributes to reducing body information privacy concerns related to the new technology of 3D body scanning technology and to increase future intention to adopt the technology. Related to the motivation that underlies the study, our

Table 2 Assessment of measurement model.

Construct	Factor loading	CR	AVE	Correlation					
				PC	PP	PR	CE	IN	BPC
Perceived control (PC)		0.90	0.75	0.80[b]					
I was in control of my navigation through the VTO service.	0.88								
I had some control over changes of the avatar.	0.89								
I was in control over the pace of my interaction with the VTO service	0.83								
Perceived personalization (PP)		0.93	0.82	0.37	0.86[b]				
I felt I had a personal conversation through the VTO service.	0.94								
The service was like talking back to me while I clicked in the VTO service.	0.93								
I perceived the VTO service to be sensitive to my needs for changing my avatar.	0.84								
Perceived responsiveness (PR)		0.93	0.82	0.60	0.49	0.85[b]			
I could communicate with the VTO service directly for changing the avatar	0.90								
The VTO service was able to respond to my request quickly and efficiently	0.88								
I could communicate with the VTO service in real time	0.93								
Consumer experience (CE)		0.94	0.63	0.44	0.75	0.53	0.77[b]		
Sensory Experience	0.83								
This VTO service makes a strong impression on my visual sense or other sense.	0.91[a]								
I find this VTO service is interesting in a sensory way.	0.94[a]								
This VTO service appeals to my sense.	0.96[a]								
Affective Experience	0.85								
This VTO service induces feelings and sentiments.	0.94[a]								
I have strong emotions for the VTO service.	0.95[a]								
The VTO service is an emotional service.	0.95[a]								
Intellectual Experience	0.88								
I engage in a lot of thinking when I encounter the VTO service.	0.93[a]								
The VTO service makes me think.	0.95[a]								
The VTO service stimulates my curiosity (and problem solving).	0.90[a]								
Adoption Intention of 3D body scanning technology (AI)		0.98	0.91	0.50	0.61	0.40	0.72	0.94[b]	
I would consider using the technology.	0.92								
The likelihood of using the technology.	0.96								
My willingness to use the technology would be high.	0.97								
The probability I would consider using the technology is high.	0.96								
Body information privacy concerns (BPC)		0.97	0.92	−0.27	−0.21	−0.26	−0.16	−0.27	0.94[b]
When I think about the 3D body scanning technology, I am concerned that my personal body information will be used for other purposes without my authorization.	0.96								
When I think about the 3D body scanning technology, I think that too much of my personal body information will be collected.	0.95								
When I think about the 3D body scanning technology, I am concerned that my personal body information will be shared with other entities without my authorization.	0.97								

[a] Factor loading for corresponding construct of consumer experience (Second-order construct), CR: Composite Reliability, AVE: Average Variance Extracted; [b] value is the square root of average variance extracted. All scales adopted from previous studies and modified for the current study: Perceived interactivity (i.e., control, personalization, and responsiveness; Wu and Wu, 2006), consumer experience (Manthiou et al. 2016), adoption intention of 3D body scanning technology (Kim and Forsythe, 2008), Body information privacy concerns (Roca et al. 2009). For example, to measure perceived control, original questions of "I was in control of my navigation through this website" has been modified to "I was in control of my navigation through the VTO service".

results provide threefold of key findings. First, within the S-O-R model, the three touch points tested here, perceived control, personalization, and responsiveness, can enhance consumers' experience with the interactive VTO service. This shows the importance of interactive features in interactive service systems. Although previous literature that focused on a 3D model-based VTO service also resulted in the importance of interactivity (Hoffman and Novak, 1996; Benlian et al., 2020; Lee et al., 2020), by suggesting different types of interactivities in this study's research model, our findings suggest further that perceived personalization's effect on consumer experience is stronger than the effects of perceived control and responsiveness. This shows that consumers perceive sensory, affective, and intellectual experiences the most when the VTO service offers personalized features (i.e., personal needs to change avatars). Further, the result showed that consumers' holistic experience with the VTO service influenced their future intention to adopt 3D body-scanning technology in the VTO service. Even though the importance of consumers' experience has been identified in various areas of consumer services (Farah et al., 2019; Lee et al., 2020), this finding is meaningful because it validates and expands the importance to the area of VTO services with 3D body-scanning technology.

Table 3 Direct and indirect effects (H1-H6).

	Model 1 (H1)		Model 2 (H2-H4)		Model 3 (H1-H6)		
Hypothesized path	**β**	***t*-values**	**β**	***t*-values**	**β**	***t*-values**	**Decision**
BPC → AI	−0.265	4.289***			−0.163	3.150**	H1 Supported
PC → CE[a]			0.129	2.325*	0.130	2.298*	H2[a] Supported
PP → CE[a]			0.569	12.643***	0.569	12.844***	H2[b] Supported
PR → CE[a]			0.162	2.859**	0.162	2.803**	H2[c] Supported
CE[a] → AI			0.684	17.229***	0.651	13.592***	H3 Supported
BPC → PC					−0.219	3.453***	H5[a] Supported
BPC → PP					−0.109	1.891	H5[b] Rejected
BPC → PR					−0.207	3.225***	H5[c] Supported
Indirect effects							
PC → CE[a] → AI			0.088	2.205*	0.084	2.198*	H4[a] Supported
PP → CE[a] → AI			0.389	10.085***	0.370	9.006***	H4[b] Supported
PR → CE[a] → AI			0.111	2.874**	0.106	2.832**	H4[c] Supported
BPC → PC → CE[a] → AI					−0.018	2.044*	H6[a] Rejected
BPC → PP → CE[a] → AI					−0.004	1.729	H6[b] Supported
BPC → PR → CE[a] → AI					−0.002	1.745	H6[c] Supported
Explained variance							
R^2 PC	-		-		0.337		
R^2 PP	-		-		0.364		
R^2 PR	-		-		0.328		
R^2 CE[a]	-		0.614		0.617		
R^2 AI	0.256		0.575		0.587		

Note. [a] Consumer experience is measured as 2nd order construct; PC: perceived control, PP: perceived personalization; PR: perceived responsiveness; CE: consumer experience, AI: adoption intention of body-scanning technology for VTO service; BPC: body information privacy concern; $p^* < 0.05$, $p^{**} < 0.01$, $p^{***} < 0.001$.

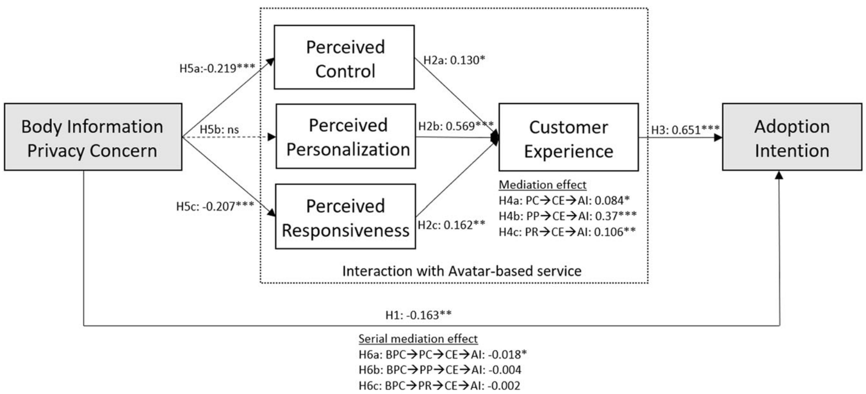

Fig. 2 Path results of model 3. PC perceived control, PP perceived personalization, PR perceived responsiveness, CE consumer experience, AI adoption intention of body-scanning technology for VTO service, BPC body information privacy concern.

Second, with respect to body information privacy concerns, when consumers had great concerns, they would disregard the perceptions of the VTO service's controllability and responsiveness. Consequently, those consumers are less likely to adopt 3D body scanning technology in VTO services. Although previous literature suggested that consumer concerns related to their body information can be a critical barrier to public adoption of 3D body scanning technology (Kim and Labat, 2013), our novel finding identified that such concerns reduced consumers' perceptions of the VTO service's interactive features. This shows that consumers' embedded concerns about their body information privacy can hamper their interactions with VTO services. However, consumers' concern about body information breaches did not influence their perceptions of the personalized features of VTO services. These results imply that consumers' concerns are related less to the personalization features than to perceptions of controllability and responsiveness. It also suggests the important role of personalization in developing VTO services. The finding is consistent with previous literature that has supported the importance of personalization features in designing e-commerce websites (Chellappa and Sin, 2005), but our contribution has a focused scope for VTO experiences with digitized garments.

Lastly but perhaps most importantly, with respect to the serial mediation effects, when consumers have an enhanced experience attributable to their perceptions of the service's personalization and responsiveness, such service experience mitigates their concerns about body information privacy when adopting 3D body scanning technology for VTO service. Previous consumer literature about consumers' future behavior has supported the serial mediating role of consumer experience enhanced by their perceptions of interactive services (Nel and Boshoff, 2019). For example, consumers' future adoption of online services (e.g., banking, hotel booking) can be influenced through a serial mediation effect of their responses to online services (i.e., perceived advantage influenced by online service inertia) (Nel and Boshoff, 2019). As the first attempt to identify the serial mediation effect of consumer experience enhanced by interactions with VTO services, the results ultimately underscore the importance of understanding consumer experience and their reaction to interactive features, that consequently can alleviate consumers' body information privacy concerns. Our attempt can expand the role of consumer experience for mitigating the information privacy issues regarding the 3D-body scanning based VTO services. Although previous information security professionals and companies have provided privacy assurance technologies (e.g., blockchain, autonomous AI, and mobile and cloud computing) (Jozani et al., 2020), according to our results, possibilities of reducing subjective perception of privacy concerns can also lie on technology-driven consumer experiences related to responsiveness and personalization features for VTO services. Further, we found that consumer experience influenced by acceptable dynamic functions, such as controllability, could not effectively reduce the negative effect of consumer concerns on their future use intention. This indicates that participants perceived privacy concerns on their body information while navigating (or controlling) the final look in detail (i.e., zoom in). This is because users would perceive their controllability over the changes of an avatar in a rational way of thinking. Thus, this, in turn, results in weak relations with sensory and affective experiences with the service. As consumers' emotional experience is less enhanced from the controllability, their lack of experience might not alleviate the negative effect of body information risk on future adoption successfully. However, our results are still meaningful as they showed that the negative influence became smaller with consumer experience enhanced from perceived control (i.e., BPC → PC → CE → FI) when compared to the direct effect of consumer concerns on future use intention (i.e., PBC → FI).

Implications

Theoretical implication. This study offers several theoretical contributions. First, this study contributes to the S-O-R literature by incorporating it into the privacy calculus theory. We examine the negative effect of body information privacy concerns in the context of VTO services. While previous researchers have suggested consumers' negative perceptions of adopting 3D body scanning technology attributable to their privacy concerns, to the best of our knowledge, this is the first attempt to empirically identify how interactive experiences alleviate the negative effect within the theoretical approaches for VTO services based on 3D body scanning technology. Further, although previous literature on VTO services has focused only on the positive effects of interactive or immersive experiences on future behaviors, no study has investigated the role of consumers' interactive experiences in reducing their concerns related to body information privacy. Second, by understanding consumers' experiences with various interactive touch points in the Avatar-based VTO service, our attempt contributes to the extension of the literature on information technology services that has greater potential to be integrated with 3D body scanning technology. During the pandemic, contactless VTO services are one of the critical services within retail sectors; thus, it is timely to understand ways to enhance consumers' experiences with VTO services. In addition, by identifying the direct and indirect roles of different types of interactivities—controllability, personalization, and responsiveness, this study provides a better understanding of VTO service users' different perceptions of interactive features while using VTO services online.

Practical implication. The results of this study have managerial implications. First, the study provides implications for the 3D body scanning technology when retailers adopt the technology for online consumers. Consumers' accurate body measurement data will help designers and retailers develop garments for inclusive consumers, such as plus size, older, and consumers with disabilities. In fact, such diverse consumers, including people with physical difficulties and aging adults represent an increasing consumer market segment with special needs for personalized clothing (Hong et al., 2017). Interactive VTO incorporated with 3D body scanning technology will provide a practical solution that allows retailers to meet these consumers' needs (i.e., accurate fit and size). Second, the results of this study have implications for sustainability of the industry. The 3D body scanning technology is expected to lower the barrier of the exclusivity of the apparel customization process that has involved high costs. Precise body measurement data taken through the 3D scanning process will help mass customizing operations, which will eventually reduce unsustainable costs generated from returning clothes. Third, with respect to consumers' experiences, our findings provide fashion retailers with a practical approach to understanding the importance of consumers' experiences when adopting a new innovative technology. Consumers who have positive experiences with Avatar-based VTO services will have a great preference to adopt the developed version of the service that incorporates this new technology. Importantly, their service experiences will eventually alleviate their concerns associated with adopting the new service with integrated 3D body scanning technology. Therefore, retailers must provide consumers with positive experiences of interactive online self-mirroring services.

Limitations and future studies

Although this study provides theoretical and managerial contributions, it has several limitations, which would suggest future research directions. The first limitation relates to the use of self-reports to examine constructs suggested in the research model. Although it is limited, as individual consumers would have different levels of psychological experiences toward VTO services, we believe that accessing theoretically validated variables through subjective self-reflection would be appropriate. In addition, the study examined possible common method errors by adopting statistical remedies including Harman's single factor test (1967), partial correlation procedures, and controlling for the effects of unmeasured latent methods factors. These procedures generated acceptable results (i.e., ratio of variance is less than 50%), which indicates that common method bias does not influence our data. Another limitation lies in the possibility of other factors as we examined a modest number of variables that represent consumers' perspective of the VTO services. For example, the perception of similarly toward an avatar might have a confounding effect within the research model. Previous scholars focused on photo-based services explained that try-on on realistic photos (or captured images) increased immersive experiences (Feng and Xie, 2019; Plotkina and Saurel, 2019; Lee et al., 2020). Although we found that participants in this study maintained positive attitudes toward their avatar ($M = 4.42$, five points refers to "strongly positive" at 5-point Likert sale), users' perception toward appearance similarity would influence perceived personalization in the model. Thus, we invite future research to discover the potential role of appearance similarity in consumers' experiences with VTO services based on accurate body measurement. Lastly, although this study developed a research model carefully, the model proposed did not attempt to specify other potential factors (i.e., age, location, culture differences) in consumers' experiences and risk perceptions of VTO services and 3D body scanning apps. For example, Ivanov et al. (2022a) focusing on mobile VTO apps found that differences between Generation Z and Millennials on research model constructs. Also, a similar study found that Chinese users did not like clothing selections offered by a specific mobile app (i.e., Zeekit; Tawira and Ivanov, 2022). These indicate that suggest future researchers with potential factors. In addition to this, in future studies, it is necessary to identify technical or psychological barriers related to service providers to validate our findings.

Data availability

Due to privacy and ethical concerns regarding participants of the study, the data cannot be made available to public. Please reach out to the corresponding author regarding the data set.

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Author contributions

SY: Conceptualization, Methodology, and Data analysis, Writing the original draft. JH: Writing the original draft. LZ: Reviewing, Editing. JB: Reviewing. All authors read and approved the final manuscript.

Competing interests

The authors declare no competing interests.

Ethical approval

The study was granted ethics committee approval from the Institutional Review Board (IRB project number: 2025601; IRB review number: 267882) regarding ethical issues including consent to participant prior to collecting data from participants.

Informed consent

Informed content was obtained from all participants. They understood that they have their own rights that are not to be infringed. The informed content addressed that participants have the right to decide what happens to the data gathered, to what they have said during the online experiment, as well as to any avatar images presented. It also explained that dataset collected during the experiment is not identifiable. Contact and affiliation information of the principal investor was presented, and the university's Human Subjects Research Program/IRB was shared with participants regarding any questions or concerns about the study. We also obtained consent to publish results of the study in academic journals.

Additional information

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