# Literature Review

Due to the dearth of literature on the subject, this research uses a scoping review technique. The goal was to thoroughly examine the existing literature and understand the current state of knowledge in the area. Although there was no clear search strategy, the review included empirical studies published in English between 2021 and 2023 about VR shopping, haptic feedback. This literature was sourced from digital libraries like IEEE Xplore, the ACM Digital Library, Scopus, Google Scholar. The review is categorised into themes relevant to the aim. It discusses virtual reality, the current state of VR shopping, haptics, and empirical studies about VR shopping and haptic feedback (refer to Appendix 4).

## XR (Extended Reality) and VR (Virtual Reality)

XR is a term encompassing virtual reality (VR), augmented reality (AR), and mixed reality (MR) (Lee and Yoo, 2021). According to Paul Milgram & Fumio Kishino (1994), a reality–virtuality continuum spanned the real environment (RE) and virtual environment (VE) at each end, and augmented reality (AR) somewhere in the middle. In XR, reality is expanded by using wearable devices to increase human sensory capacity and notice things that ordinary people cannot (Mann *et al.*, 2018). Virtual reality provides users with a three-dimensional setting where they can directly perceive and engage with virtual objects in a three-dimensional space (Mark R. Mine *et al.*, 1997). VR interfaces come in a variety of forms, from mobile ones like head-mounted glasses with screens in front of the eyes to stationary ones like specially created rooms with numerous huge screens (Loureiro *et al.*, 2019).

## HCI and VR

*“The underlying belief motivating most virtual reality (VR) research is that this will lead to more natural and effective human–computer interfaces.”*

(Mark R. Mine *et al.*, 1997, p. 1)

Human-computer interaction is about designing products that are interactive to help people in their daily and professional lives (Sharp *et al.*, 2002). The goals of HCI are to create systems that are user-friendly, secure, and operational (Issa and Isaias, 2022). These goals are directly associated with the services that the system provides, how quickly the tasks can be achieved, and ensuring user satisfaction (Issa & Isaias, 2022). VR emphasises designing human-computer interfaces that enable natural or intuitive interaction with the three-dimensional virtual environment (Doerner *et al.*, 2022). Users are allowed to engage with virtual objects more naturally and realistically due to the increasing appeal of VR platforms (Chen *et al.*, 2022a).

## Presence

Presence refers to the feeling of being present in a mediated or virtual environment (Minsky, 1980). According to Kim and Biocca (2006), presence occurs when the outside information from their physical environment is blocked, enabling the user's mind to concentrate on the virtual environment. Sheridan (1992) identified three determinants of presence: the extent of sensory information, the control of the relation of sensors to the environment, and the ability to modify the physical environment. Retailers are increasingly embracing virtual reality (VR) in online shopping to improve customers' sense of presence (Chen *et al.*, 2022a) because it allows users to visualise, manipulate, and interact with complex data (Aukstakalnis and Blatner, 1992). Presence is based upon theories such as media richness theory (Jang and Hsieh, 2021) and theory of spatial presence (Schubert, 2009).

## Shopping Motivation and the need for touch

People shop for different psychological needs other than just acquiring the product (Tauber, 1972). Shopping motivation can be task-oriented or activity-oriented, focusing on the activity's increased sensory involvement and emotional payoff (Babin *et al.*, 1994). Babin et al. (1994) categorises shopping values in two aspects: hedonic and utilitarian. Hedonic values relate to multisensory, imaginative, and emotional aspects of customer behaviour (Hirschman and Holbrook, 1982). Arnold and Reynolds (2003) further classified hedonic shopping experiences in six categories: Adventure (stimulation), social (shopping with people), gratification (uplifting mood), idea (to keep up with trends & innovations), role (shopping for others), value (shopping for sales). Utilitarian values are task-oriented, (Babin *et al.*, 1994) focused on cost, task efficiency and achievement (Hye-Shin Kim, 2006). Utilitarian shopping value is associated with task completion, hedonic shopping value is associated with the pleasure and escapism of shopping (Babin *et al.*, 1994).

Peck and Childers (2003a) described need for touch (NFT) as a desire to gather and use information gained through the haptic system. This need is based on consumer motivations related to problem-solving and enjoyment (Hirschman and Holbrook, 1982). Customers can evaluate product quality through direct experiences and haptic cues (Peck and Childers, 2003a). Preferences for touch are varied among customers (Peck and Childers, 2003a). Autotelic NFT is hedonic, pleasure-oriented, whereas instrumental NFT is goal-driven and utilitarian (Peck and Childers, 2003a). The individual’s need for touch significantly influences the attainment of hedonic shopping value in VR shopping (Alzayat & Lee, 2021).

## VR Shopping

Virtual reality (VR) offers an innovative method of exploring products and retail environments combining the advantages of offline and online shopping (Xue *et al.*, 2020). As visual display technologies and VR platforms gain popularity, VR is expected to influence how online shopping develops (Chen et al., 2022). VR is taking centre stage in today's business world as it helps consumers evaluate brands (Xi & Hamari, 2021). The sensory stimuli in VR can impact shopping experience in which consumers investigate products and the retail environment (Bin Kim and Jung Choo, 2023). Retailers can offer their customers innovative digital experiences using VR technology like unlimited opening hours comparable to online stores and a sense of presence comparable to physical stores (Lee *et al.*, 2022).

Emperia, an immersive retail startup collaborates with brands like Lacoste, Bloomingdales, Dior, and Ralph Lauren to create virtual stores (Grant, 2023). London-based company Xydrobe plans to introduce a virtual luxury shopping experience in 2023 with stunning visuals, scent, temperature, and sound effects (Cruz, 2022).

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| Study | Context | Stimuli | Focus |
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| Chen et al. (2022) | Chair and flower | A smartphone based VR | Impulse buying behaviour, presence |
| Meirinhos et al. (2022) | Refrigerator | 3D computer running VR environment | Purchase Intention, User satisfaction, presence |
| Alzayat and Lee (2021) | Clothes, accessories, and tools | 3D VR retail space | Hedonic and utilitarian shopping value |
| Jin *et al.* (2021) | Clothes & accessories | 360-degree-based VR store videos | Perceived store attractiveness |
| Bin Kim and Jung Choo, (2023) | Clothes & accessories | A VR store | Perceptual curiosity, consumer creativity |
| Kim and Ha (2021) | Clothes | Oculus Quest 2 | Tangible Interactions |
| Sina and Wu  (2023) | Clothes | 3D virtual reality using Sketch up | User satisfaction and purchase intention |
| Ruusunen *et al. (*2023) | Furniture | 360- virtual store | Need for touch |
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Table 1: Summary of VR Shopping

Earlier studies on VR are focused on different product categories such as a chair and flowers (Chen et al., 2022), a refrigerator (Meirinhos et al., 2022), clothes & accessories (Alzayat and Lee, 2021; Jin *et al.*, 2021; Bin Kim and Jung Choo, 2023) and handheld tools (Alzayat and Lee, 2021), clothes (Kim and Ha, 2021; Sina and Wu, 2023) and furniture (Ruusunen *et al.*, 2023). Refer to table 1 for detailed information

The existing studies focusing on VR shopping in the fashion retail context have provided valuable insights into consumer behaviour. However, these studies primarily focus on consumer behaviour which has visual and auditory stimuli whether it is impulse buying behaviour (impromptu shopping) (Chen et al., 2022), purchase intention (Meirinhos et al., 2022) hedonic and utilitarian shopping value (Alzayat and Lee, 2021) , user satisfaction (Sina and Wu, 2023), perceived store attractiveness (consumer’s perception if the store is attractive) (Jin *et al.*, 2021) and perceptual curiosity (a person's desire to know more about the VR store) (Bin Kim and Jung Choo, 2023). There is a notable research gap concerning the understanding of consumer responses in VR shopping with tactile sensations and its impact on their shopping experience.

Purchase intention measures the customer’s possibility of buying a specific product or service in the future (Wu *et al.*, 2011). Higher intention implies higher chances for purchase (Martins *et al.*, 2019). Purchase intention is based on the theory planned behaviour which is about an individual intention to change their behaviour (Armitage and Conner, 2001). Chen et al. (2022) suggests that a strong sense of presence can increase impulsive purchases. However, Meirinhos et al. (2022) found that there is no correlation between the presence and making a purchase. These conflicting findings highlight the need for further research to explore the impact of presence and purchase intention in the VR shopping environment.

## Haptic Feedback

Haptics, as defined by Srinivasan and Basdogan (1997), refers to tactile interactions with a real or virtual (Srinivasan and Basdogan, 1997) environment, involving information retrieval and manipulation. When users interact with objects, sensory data is transmitted to the brain and motor commands are sent, while haptic interfaces apply torque commands to simulate proper reactions and create the tactile perception of virtual objects (Srinivasan and Basdogan, 1997). Haptic information, which we receive when we physically touch something, is essential for assessing products with different types of materials, such as texture, hardness, warmth, and weight (Peck and Childers, 2003b). Haptic Human-Computer Interaction (HCI) involves the user, the interface device for sensing and transmitting information, and the computer-generated virtual environment for user interaction (WANG *et al.*, 2019).

Given the rapid growth of VR technologies, haptics are vital in enhancing the user experience by providing multisensory feedback (Huang *et al.*, 2022). In VR systems, haptic feedback is created as a response to user interactions, calculated by a computer programme, and delivered through an output device to stimulate the user's senses (Muender *et al.*, 2022). This stimulation shapes how the real or virtual world is perceived (Muender *et al.*, 2022). The user experience and impression of immersion in the virtual world are inextricably tied to haptic feedback (Muender *et al.*, 2022). Haptics feedback in VR can be categorised as active, utilising actuators to apply force on the user for generating haptic feedback (Zenner and Kruger, 2017) and passive where the computer observes user interactions without the need for actuators to exert force on the user (Hinckley *et al.*, 1994; Zenner and Kruger, 2017).

Designers can create various interactions in VR environments (Auda *et al.*, 2021). However, these interactions are constrained because the user must use controllers to handle the VR objects (Auda *et al.*, 2021). Although the controllers have excellent input abilities, their output abilities are limited (Auda *et al.*, 2021). To overcome this, researchers are providing multiple approaches to include haptic feedback in VR environments. For example, body-worn (Fang *et al.*, 2020; Hoppe *et al.*, 2021), drones (Auda *et al.*, 2021; Hoppe *et al.*, 2018), handheld (Kovacs *et al.*, 2020; Sinclair *et al.*, 2019), wearables (Fang *et al.*, 2020; Sinclair *et al.*, 2019).

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| Study | Context | Stimuli | Focus |
| Luangrath et al. (2022) | Clothes | Vicarious haptic effect | Psychological ownership and product valuation |
| Gibbs et al. (2022) | Virtual ball | Haptic (vibrotactile) feedback | Presence |
| Felip et al. (2023) | Chair | Passive haptics | Purchase intention |
| Palacios-Ibáñez et al. (2023) | Umbrella | Passive haptics | Product perception |

Table 2: Summary of Haptic feedback

Prior research has demonstrated the positive impact of haptic and visual stimuli on user presence and purchase intentions in VR. Refer to table 2 for detailed information.

Luangrath et al. (2022) explored the vicarious haptic effect (observing a virtual hand touching the product) and discovered that simply exhibiting the touch is ineffective; the hand needs to touch the product for valuation. Gibbs et al. (2022) provided vibrotactile haptic feedback for a virtual ball and found that both visual and haptic feedback enhances presence. Similarly, Felip et al. (2023) in their study utilised passive haptics (using physical objects as proxies to provide users information through their shape) and discovered that user’s sense of presence was enhanced when both visual and haptic stimuli and the purchase intention was slightly higher when the product could be touched (Felip *et al.*, 2023). Palacios-Ibáñez et al. (2023) conducted a study using passive haptics with an umbrella, finding that presenting a product with haptic feedback positively influences purchase intention.