Perceived interactivity in real estate APP increases consumers' psychological well-being: A moderated mediation model

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Funding: This study was financially supported by Humanities and Social Sciences Planning Project of the Ministry of Education (No.21YJA630014)

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Purpose

This study empirically analyses the perceived interactivity in real estate APP affects consumers' psychological well-being from the perceived interaction theory. Especially, human-machine interaction is to stimulate perceived interactivity between humans and machines to positively impact consumers' psychological well-being.

Design/methodology/approach

A sample of 568 consumers found that perceived interactivity influences on perceived value and affects psychological well-being, and that perceived value partially mediates the effect of perceived interaction on psychological well-being.

Findings

The findings are that privacy concerns not only negatively moderate human-information interaction on perceived value and negatively moderate the indirect effects of human-information interaction on users' psychological well-being through perceived value.

Originality

This study expands the context on perceived interaction and psychological well-being in the real estate APP field, validating the mediating role and boundary conditions of perceived interactivity created by human-machine interaction in real estate APP on consumers' psychological well-being. Prior studies are blurred whether perceived interactivity improves consumers' psychological well-being.

Abstract

This study empirically analyses the perceived interactivity in real estate APP affects consumers' psychological well-being from the perceived interaction theory. Especially, human-machine interaction is to stimulate perceived interactivity between humans and machines to positively impact consumers' psychological well-being. However, prior studies are blurred whether perceived interactivity improves consumers' psychological well-being. A sample of 568 consumers found that perceived interactivity influences on perceived value and affects psychological well-being, and that perceived value partially mediates the effect of perceived interaction on psychological well-being. The findings are that privacy concerns not only negatively moderate human-information interaction on perceived value and negatively moderate the indirect effects of human-information interaction on users' psychological well-being through perceived value. This study expands the context on perceived interaction and psychological well-being in the real estate APP field, validating the mediating role and boundary conditions of perceived interactivity created by human-machine interaction on consumers' psychological well-being.

Keywords: perceived interactivity; real estate APP platforms; perceived value; privacy concerns; sustainable development; psychological well-being

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1 Introduction

The application of human-machine interaction (HCI) technology in real estate APP has deeply influenced all aspects of public lives, changing not only the traditional way of accessing information, but also the traditional way of consumption, including consumers' buying styles, purchasing decisions and buying behaviour. The perceived interactivity (Tang & Zhu, 2019; Yin & Lin, 2022) created through the integration of HCI with real estate APP expands the scale of online users and enables an effective match between real estate supply and consumer demand. HCI technologies (e.g. AI) empower real estate APP to perform market analysis, prediction and judgement as well as accurate insight into market needs, aiming to integrate the scientific principles of well-being into the interface design, functional development and system application of real estate APP to enhance users' online service experience (Hilken et al., 2017), thereby creating positive emotions for users in perceived interactivity, which can be used to enhance individual and group well-being, leading to psychological well-being (Wheatley & Buglass, 2019). Perceived interactivity is thought to have the effect of stimulating pleasant experiences for individuals, supporting the realisation of self-worth and improving positive personal feelings (Sharma, 2019; Zhou, 2020; Yin & Lin, 2022). Today, real estate APP applications are increasingly focusing on HCI and its design of perceived interactivity, which in turn promotes psychological well-being and happiness. From these objective phenomena, it appears that perceived interactivity affects the users' psychological well-being, and therefore it may be divided in practical terms into human interaction with customer service and human interaction with the information provided by real estate APP. These two types of perceived interactivity are academically defined as human-human interaction and human-information interaction (Lee & Lee, 2019; Yin & Lin, 2022).

The level of HCI and consumer experience in real estate APP has been enhanced with the application of AI interaction technologies (Caprariello et al., 2013), and perceived interactivity (e.g. personalized recommendations, online customer service windows, pop-up advertisements, etc.) leads to continued perceived value for consumers, and accordingly, consumer psychological well-being is expanded and enhanced (Ong et al., 2015). Thus, individuals may be influenced by perceived interactivity, resulting in a rich perceived value of the real estate APP and the services and products offered by the real estate APP, and perceived interactivity is seen to induce a positive effect on individuals' pleasant experiences, support self-worth realization and improve personal interpersonal relationships (Jiang et al., 2016), contributing to consumer HCI and thus influencing individual well-being. Relatively infrequent studies, nonetheless, have explored and examined the mechanisms and boundary conditions of perceived interactivity affecting psychological well-being. Given the important role of psychological well-being for personal well-being (Verduyn et al., 2017), this study relies on a structural equation modeling research design that focuses on two questions. First, do the human-human interaction and human-information interaction arisen from perceived interactivity influence consumer psychological well-being via the mediating role of perceived value and in turn consumer psychological well-being since previous works have demonstrated that perceived value serves as an important prerequisite for the development of consumer behaviour during HCI? And

second, immediately afterwards, do the mediating mechanisms by which perceived interactivity affects psychological well-being show different effects in different usage contexts?

The stronger the perceived interactivity and the more significant the behaviour of individuals' using real estate APP are to collect real estate advice online. The application of interaction technologies including Chatbot, face recognition and digital personal assistant in real estate APP allows users to view the properties they need online and fully understand the relevant information through real estate APP at any time, which in turn enhances the level of perceived interactivity and consumer experience, thus promoting mental health and well-being. Self-determination theory states (Van den Broeck et al., 2016) that individuals place considerable importance on psychological needs regarding autonomy, personal growth, interpersonal relationships and physical well-being as a reference point in relation to psychological well-being, which in turn influences their subsequent perceived value in perceived interactivity. In other words, perceived value partially mediates the variable relationship between perceived interactivity and psychological well-being. Related research also confirms that in the usage contexts of social media website, users perceive the perceived usefulness and perceived ease of use from interaction with social media (Lee & Lee, 2019), and that these perceived values tend to motivate individuals to develop psychological well-being (Abaidi et al., 2022) and motivate users to respond by making high levels of self-acceptance, personal growth, life goals, positive interpersonal relationships, environmental control, independence, self-actualization, and vitality of life as a response, i.e. psychological well-being. As such, in conjunction with self-determination theory, this study proposes that perceived interactivity created by HCI may have indirect and positive influences on individuals' psychological well-being via the mediating effect of perceived value.

In addition, the mechanisms by which perceived interactivity stimulates perceived value and psychological well-being are influenced by the differential levels of individuals' privacy concerns. From a privacy concerns perspective, the exact consumer psychology and behaviour of individuals in a given situation when confronted with a privacy breach should also be considered in light of the privacy risks and security that accompany technology in bringing well-being to users (Cho et al., 2019; Schomakers et al., 2019). For example, while individuals access useful information about a house in perceived interactivity, on the one hand, GPS-based navigation helps the users to find the location of the house as soon as possible, making it easier for them to see the house on site before purchasing. Moreover, the detailed information of the house is displayed in the real estate APP software, making it easy for consumers to have a close look about the house, including the location of the available houses, the price and the internal structure. On the other hand, information about the consumers is also exposed to the real estate APP and may be at risk of privacy violations. As such, the issues of individual privacy concerns in perceived interactivity are very important, as they help to protect consumers' legitimate rights and interests, enhance their sense of security, reduce the risk of personal information spillage during HCI, and enhance perceived value (Peng et al., 2018; Chung et al., 2021). Clearly, privacy concerns are an essential moderating variable in the perceived interactivity process and play an important role in enhancing consumers' sense of security and gaining perceived value (Li et al., 2019). Privacy concerns can help to reduce the negative effects of perceived interactivity and facilitate the acquisition of perceived value by consumers. As such, this study builds on the theory of perceived interactivity (Salancik & Pfeffer, 1978) and suggests

that privacy concerns play a weighting role in the 'perceived interactivity—perceived value-psychological well-being' research framework.

In summary, real estate APP is a widespread and emerging phenomenon. Adequate understanding of the influence of perceived interactivity on psychological well-being in the context of real estate APP applications can be adapted to HCI design in different themes to increase users' online human interaction and intelligent information searching (De Cates et al., 2015; Srivastava & Srivastava, 2019). Unfortunately, although indirect research on perceived interactivity and well-being has increased in the last decade, research overall remains limited. For example, Lee & Lee (2019) and Yin & Lin (2022) referred to a potential relationship between perceived interactivity and perceived value, while Abaidi et al. (2022) demonstrated that perceived value represented a major source of psychological well-being. However, previous research on perceived interactivity theory has been limited mainly to research on social media and online communities. Contrastingly, perceived interactivity theory has infrequently been extended to analyze predictors of psychological well-being in real estate APP, and research remains scarce on perceived interactivity as a source of psychological well-being. Moreover, the findings of these previous studies do not lead to consistent conclusions and are difficult to draw on in the real estate APP field. Thereby, this work utilizes perceived interactivity theory to investigate the influence mechanisms of psychological well-being in real estate APP, bridging the gap in the field.

Overall, this study has the following contributions. First, we synthesized prior research on the relationship between perceived interactivity and individuals' psychological well-being. Although previous literature has addressed the exploration of perceived interactivity in relation to individuals' psychological well-being in the fields of information technology and mobile information technology, the results have been inconsistent and limited. This study confirms the mechanism of perceived interactivity on the psychological well-being of real estate APP users and expands the literature on perceived interactivity in the field of real estate APP research. Second, drawing on perceived interactivity theory, we propose that perceived value is a critical mediating mechanism that mediates perceived interactivity on psychological well-being. The findings will guide managers on considering perceived interactivity as a factor influencing consumers' psychological well-being. Third, our consideration of privacy concerns adds to the overall understanding for the boundary under which perceived interactivity affects perceived value and psychological well-being.

2 Theoretical foundation and research hypotheses

2.1 Real estate APP

Real estate APP has been described as "a HCI product used to link the public demand for intelligent housing services to consumers' perceptions of healthy, safe, comfortable, and environmentally friendly active lifestyles and a product to influence their behavior" (Milkovich et al., 2020; Yang et al., 2023). For example, intelligent activities such as virtual reality (VR) viewing, VR talking, and VR showing on real estate APP platforms are becoming more and more popular, increasingly becoming a hot topic in the society and a major source for the public to assess the perceived value. In the use scenario of real estate APP, HCI technology makes real estate APP cover complete online and offline marketing scenarios, reconstructs the real estate marketing process, and stimulates users to perceive a series of perceived values. For example,

the functional value brought to the users by the specific functions of the real estate APP itself, the experiential value generated by the HCI, and the informational and affective value brought to the users by the customer service of the real estate APP, etc. These perceived values generated by the perceived interactions redefine the positive impacts of HCI on consumers, which contribute to the consumers obtaining a higher level of emotions such as pleasure, elation and joy, as well as a more satisfying quality of life. The real estate APP, supported by HCI technology, integrates the scientific principles of well-being into the interface design, function development and system application of the real estate APP, which enhances the users' online service experience by analyzing, predicting and judging the market supply and effectively matching the market demand (Hilken et al., 2017). Thus, positive emotions are created for users in perceived interactivity to achieve the goal of motivating individuals to generate perceived value and in turn promote psychological well-being (Wheatley & Buglass, 2019).

Previous research has found that as an attractive HCI product, the real estate APP improves the public experience of a full range of high-quality and efficient services such as second-hand, new, rental, and renovation, and provides a variety of benefits in HCI in terms of perceived usefulness and perceived ease of use for members of the community (Sook, 2019). In HCI, consumers, through the real estate APP, realize online selection, VR viewing, online signing and other new scenes of online home purchase, breaking the traditional time and space constraints with VR viewing effectively presenting the real situation of the house (such as the real presentation of the size of the house, orientation and geographic location), so that consumers can understand and experience the details of the real house. Therefore, real estate APP provides HCI with the comprehensiveness of housing service information and the timeliness of communication, and more efficiently helps consumers to understand the housing situation more scientifically and comprehensively (Kim & Yoon, 2020). Obviously, real estate APP helps to build a full-process service of real estate marketing through online customer acquisition, online follow-up and online transaction, and based on this, it influences consumers' perceived interactions with real estate APP, which in turn creates more positive social relationships and healthier lifestyles for individuals.

In particular, with the development of HCI technology, real estate APP increasingly allow consumers to experience perceived value in terms of full autonomy, environmental mastery, sense of purpose in life, and self-acceptance (Sagone & De Caroli, 2014; De Caroli & Sagone, 2016), among others, to experience perceived value and influence the role effect of consumers' psychological well-being sources. COVID-19, especially, has prompted HCI technology to become an important factor in influencing perceived interactive behavior on the real estate APP platform (Yoon, 2020; Kim & Yoon, 2020), and has increased the public interest in the positive relationship between these perceived values and psychological well-being. Undoubtedly, the perceived interaction drives consumers to generate perceived benefits and perceived losses from real estate APP, and on the foundation of this, they form a comprehensive evaluation of the effectiveness of using real estate APP, which in turn stimulates the individuals' perceived value, and promotes their mental health and well-being. The issue of perceived interaction between individuals and real estate APP is indisputably crucial. Therefore, studying HCI in the context of real estate APP usage not only helps to satisfy the multi-level demand for mental health and wellbeing, but also obtain sustainable development in a competitive marketplace,

which has become an important research frontier of academic interest (Seo et al., 2017; Lee et al. 2022).

2.2 Perceived interactivity

Perceived interactivity is described as ‘’the extent to which the users regard their experience as a simulation of interpersonal communication and how they feel in front of others in real society’’(Tang & Zhu, 2019;Thorson & Rodgers, 2006; Zhao & Lu, 2012). Perceived interactivity by HCI emphasizes the impact of system technical features on the level of user interaction (i.e., machine interactivity); the process of demonstrating user-user information exchange (i.e., human interactivity, or social interactivity); and user perceptions after using HCI technologies or experiences; and a comprehensive evaluation of these characteristics (Sundar et al., 2016; Hsu et al., 2015; Zhao & Lu, 2012; Wu et al., 2010; Yin & Lin, 2022). The definition reflects the degree to which users perceive or experience technological features (Lee, 2000). For example, the perceived interactivity with mobile banking enables banks to serve customers with convenient, efficient, and relatively secure technological features and to innovate digital banking services as they are perceived and experienced by customers (Yin & Lin, 2022). Perceived interactivity helps individuals to apply the ability granted by technological features to access large amounts of online information and display its quality (Szuprowicz, 1996). For example, users can use the interactive features in Facebook to find health information to meet their outcome expectations and self-management capabilities (Lin & Chang, 2018). The study by Sharma (2019) and Zhou (2020) found that users can visit their bank accounts and deal with a range of financial and non-financial transactions whenever and wherever they want through the perceived interactivity (human-human interaction, human-information interaction, human-system interaction) of mobile banking. The constitutive dimensions of perceived interactivity may vary in different contexts of intelligent technology applications (Hsu et al., 2015). Accordingly, perceived interactivity in different contexts is a multidimensional concept consisting of different constructs (Zhao & Lu, 2012; Lin & Chang, 2018; Lee & Lee, 2019). Hoffman & Novak (1996) developed the well-known two-dimensional structure of perceived interactivity, i.e., technical interactivity and social interactivity. With the practical revelation and theoretical contribution of the application for two-dimensional perceptual interactivity proposed by Hoffman and Novak (1996), the multidimensional concept of perceptual interactivity has been further developed and applied. Yin & Lin (2022) proposed a three-dimensional perceived interactivity (i.e. human-human interaction, human-information interaction, and human-system interaction) in the context of mobile banking to reflect the various characteristics of HCI. Lee & Lee (2019) proposed human-to-information interaction and human-to-human interaction, i.e. the proposed two-dimensional perceived interactivity, using ACG social media sites as a research context. Zhao & Lu (2012) adopted Hoffman and Novak's (1996) view to examine interactivity in two dimensions, user-to-user and user-to-system, and defined perceived interactivity as control, playfulness, connectedness, and responsiveness.

Based on the discussion of the multidimensional nature of perceived interactivity of previous studies, we define perceived interactivity in this study as "users' experience of their use through information technology as communication and response in interpersonal communication when facing others in the real world" and use two constructs to further elaborate this interpersonal interaction degree and perception, i.e., human-human interaction

and human-information interaction as the constituent dimensions of perceived interactivity. These constructs capture the main elements of perceived interactivity in prior researches and significantly reflect the users' perception and experience of technical features. Being one of the representative smart technologies, this study defines the real estate APP in the above two dimensions as follows. Human-human interaction is described as communication between consumers and online customer service using the real estate APP. It emphasizes users' perception and experience of the quality and content of the services provided by online customer service, reflecting the individuals' feelings and emotional reactions based on technical characteristics. And human-information interaction refers to the information interaction between people and the services provided by the real estate APP. It emphasizes the contribution of the high-level interaction that exists between users and information to the search for goal efficiency, and reflects users' feelings and emotional reactions to the use of the information environment and content provided by the real estate APP (Lin & Chang, 2018; Srivastava & Srivastava, 2019). Human-human interaction and human-information interaction function together to realize the interaction between human and machine (Lee & Lee, 2019; Lu et al., 2010; Zhao & Lu, 2012; Hsu et al., 2015). Qiao (2019) and Sundar et al. (2016), from a technological perspective, perceived interactivity created conditions for human-computer communication practices that provided the basis for interaction between message senders, receivers, and systems. However, most previous studies have explored website interactivity or online marketing (Sicilia et al., 2005; Song & George, 2008; Lee & Lee, 2019; Yin & Lin, 2022), while the focus on information technology, especially real estate APP, in terms of perceived value and well-being has not been prominent. As such, this work utilizes perceived interactivity theory to examine predictors of psychological well-being for real estate APP users to bridge the gap in the field.

2.3 Privacy concerns

Privacy concerns have been defined in the existing literature from the the perspective of the individual as "anxiety about personal privacy" (Yun et al., 2019), and "concern about controlling access to and subsequent use of personal information" (Tan et al., 2012), which reflect individuals' attitudes and behavioral tendencies and significantly influence individual use behavior. From the perspective of the privacy sources, privacy concerns have been described as "an individual's awareness and assessment of the risks associated with invasion of privacy (Barnes, 2006; Boyd, 2008), which reflects the fact that privacy concerns focus on an individual's concern about who has access to his private information and how it will be used". With the more and more widespread usage of HCI technology (e.g., real estate APP, social APP), the discussion of privacy concerns has gradually become the topic of many studies (Yang et al., 2023). Generally, individuals are more likely to be concerned about their privacy when they find that information is being used without their permission or knowledge, or when the expected usages of the information are not explicitly stated (Barth and de Jong, 2017). In addition, the solicitor of the information can sell or provide information about its users to third parties without informing the recipients of the information about how it will ultimately be used (Yang and Guo, 1996; Malhotra et al., 2004). Therefore, the secondary use of individual information is another privacy concerns issue for the public. It can be inferred that HCI in real estate APP usage contexts is clearly influenced by individual privacy concerns. With this in mind, this study defines

privacy concerns as individuals' awareness, evaluation, and behavioral intentions regarding the risk of privacy invasion or leakage when using real estate APP.

There are a number of privacy concerns issues that deserve serious consideration for users of real estate APP. First, according to Krasnova et al. (2009) and Rathore et al. (2017), public or semi-public user information might lead to risks of identity theft, sexual exploitation, online stalking, and cyber harassment. Second, according to Rosenberger et al. (2017) and Zhu et al. (2017), posting private information in real estate APP put users under public scrutiny, which may create permanent records that can negatively impact users in the future. Third, according to Boyd (2008), Hurwitz (2013), Feri et al. (2016) and Punj et al. (2019), the viral nature of news update undermined privacy protection by making personal information more accessible and visible. Prior research (Adorjan & Ricciardelli, 2019; Liu et al., 2019) pointed out that the potential risks individuals face in losing control of their private information can be achieved through either behavioral or cognitive approaches to privacy control. Individuals under the cognitive approach believe they can cope with threats posed by virtual environment, while individuals under the behavioral approach take action to alter adverse events (Shane-Simpson et al., 2018). Therefore, it can be inferred that the in-depth understanding of privacy concerns of real estate APP developers can help to address the impact of perceived interactivity between individuals and real estate APP on perceived value and its outcomes. Considering the negative impact of privacy concerns, real estate APP developers can develop different marketing strategies to improve the perceived interactivity between users and real estate APP depending on their level of privacy concerns. Research has shown that different degrees of privacy concerns have inconsistent effects on consumers' perceived value (e.g., perceived usefulness and perceived ease of use). The higher the degree of privacy concerns is, the lower the perceived usefulness and the less significant the effect on perceived ease of use. The lower the degree of privacy concerns is, the more significant the effect on perceived usefulness and perceived ease of use (Yang et al., 2023). For users with higher degree of privacy concerns, real estate APP developers can improve the perceived usefulness of real estate APP to increase the perceived value. Real estate APP developers can determine the specific perceived usefulness of real estate APP, and then develop corresponding functions to satisfy users’ demands for perceived value, thus increasing their positive evaluations of real estate APP and promoting mental health. Comparatively, for users with lower degrees of privacy concerns, real estate APP developers can increase the perceived value by developing functions that users perceive to be both easy to use and useful, as both types of perceived value make users more salient in perceived interactivity (Xie et al., 2019) and increase its positive impact on individual psychological well-being. Therefore, this study aims to explore the impact of perceived interactivity in real estate APP to increase consumers' psychological well-being from the perspective of privacy concerns and to understand the boundary conditions of privacy concerns on the mechanism of perceived interactivity between users and real estate APP, which provides valuable references to real estate APP developers in designing their products and making their marketing strategies, thus providing more effective services to real estate APP users.

2.4 Perceived value

Perceived value is a concept based on consumers' subjective impressions, which refers to the criteria consumers employ to measure the magnitude of the value embedded in a product,

reflecting their subjective and personalized evaluations of the perceived benefits and perceived losses for goods or services (Hapsari, 2016). Previous research has argued that "perceived value is a prior determinant that influences an individual's use behavior and making product choices" (Sánchez-Fernández & Iniesta-Bonillo, 2007; Joe et al., 2017). Therefore, although there are more factors for consumers to choose to use a certain product or service, perceived value is the main predictor of their consumption behavior and tendency (Fang et al., 2018). In other words, the subjective evaluation of perceived benefit and perceived loss is one of the main criteria that influence consumers to use a certain good or service. For example, individuals get additional benefits and satisfaction through HCI in the process of using the APP (e.g., self-acceptance, autonomy, personal growth, purpose, personal mastery, and positive social relationships), which in turn results in a positive affective connection between the user and the APP, and thus increases perceived value (Hsu & Lin, 2016; Tang & Zhu, 2019). As a matter of fact, "consumers' comprehensive evaluation of commodity utility formation based on perceived benefits and perceived losses" has become a commonality that exists in the research of perceived value theory (Jiang et al., 2016; Levesque and McDougall, 1996). Therefore, in combination with previous research, this study defines perceived value in the context of real estate APP usage as the users' perceived preference and comprehensive evaluation of real estate APP based on their existing subjective impression towards real estate APP. In other words, when users browse information on real estate APP or interact with customer service, they form an overall preference and comprehensive evaluation for goods or services involved in real estate APP based on their existing subjective impressions. As seen, the higher the degree of perceived value, the more benefits and experiences users obtain through perceived interactions in the process of using real estate APP, which builds an excellent association between users and real estate APP, and thus increases perceived value (Hsu & Lin, 2016).

In the context of real estate APP use, perceived value emphasizes consumers' subjective perception of the specific value of using a real estate APP after comparing the perceived benefits to the costs they pay (Zeithanl, 1988), reflecting the important role it plays in influencing human-computer interactions. Therefore, perceived value is an important predictor of user behavior (Lee et al., 2014; Hsu and Lin, 2016; Yang et al., 2023), generating specific satisfaction of various user needs, which in turn affects users' perceptions of real estate APP. With the continuous satisfaction of the individual experience, the users develop a positive view of the real estate APP, and in the human-computer interaction with the real estate APP, the users continue to feel emotions such as pleasure, elation, and gladness, as well as the assessment of satisfaction with life, oneself, and social relationships based on the quality of life, which enables them to develop a high level of personal mastery, and positive social relationships, and thus enhances the effective mechanism of psychological well-being. Undoubtedly, real estate APP satisfy users' basic value demands, which is the foundation for the formation of perceived value (Yang et al., 2023), and the accumulation of users' perceived value towards real estate APP affects their emotional superposition for real estate APP. That is, users' psychological well-being towards real estate APP is based on the recognition of perceived value by real estate APP. Previous research shows that consumers perceive perceived usefulness and perceived ease of use from interactions with APPs (Lee & Lee, 2019), these perceived values tend to motivate individuals to develop psychological well-being (Abaidi et al., 2022). For example, users are prompted to respond with high levels of self-acceptance, personal growth,

life goals, positive relationships, environmental control, independence, self-actualization, and life vitality. In other words, perceived value elicited from perceived interactions in human-computer interactions can indirectly and positively influence an individual's psychological well-being. However, despite an increase in indirect research on the relationship between perceived value in perceived interactions and psychological well-being over the past decade (Lee & Lee, 2019; Yin & Lin, 2022), there is still limited research involving the real estate APP domain. In this regard, this study reviews to further examine the potential relationship among perceived interaction, perceived value, and psychological well-being of perceived value as a major source of psychological well-being, and responds to the studies of Zeithanl (1988), Wang et al. (2021), and Yang et al. (2023) to enrich the conceptualization and application context of perceived value theory.

2.5 Model and hypotheses

2.5.1 Effects of human-human interaction of real estate APP on perceived value

Human-human interaction refers to individuals using machines (e.g. social media sites, banking APPs, real estate APP, etc.) to both deliver and receive information and to obtain reciprocal responses from the information recipient (Ko et al., 2005; Zhao et al., 2012; Hsu et al., 2015; Wei et al., 2015). Human-human interaction reflects an individual's psychological feelings and emotional responses when connecting with others or engaging in other social interactions, as well as perceptions of the speed and frequency of posting content with reciprocal responses from other users (Zhao & Lu, 2012; Lin & Chang, 2018). Human-human interaction increases health information exchange between individuals, facilitates individuals' expectations of improved self-management skills and enhanced social relationship outcomes, and enhances individuals' confidence in their belief that the self uses intelligent machines to contact others (Lu et al., 2010). Undoubtedly, human-human interaction is interpersonal interaction that enables communication, information exchange and even dialogue through virtual environments (Lin & Chang, 2018). For example, Lin & Chang (2018) have demonstrated, based on the research work of Hsu et al. (2015), that individuals can engage in human-to-human interaction with bank customer service agents through mobile banking APPs and obtain information exchange from such interpersonal interactions.

According to Lin & Chang (2018), real estate APP can prompt interpersonal interactions between individuals and others in an online environment, thus promoting social relationships. Among other things, human-human interaction by individuals with high levels of subjective knowledge can create online friendships and generate perceived value (Xiao et al., 2012; Ba & Wang, 2013). For example, individuals can connect and communicate with their peers through social media to fulfill the need to socialize and to obtain perceived social value, perceived entertainment value, and perceived functional value. Research has been conducted to find that human-human interaction positively influences not only the users' perceived safety value, but also the perceived value (e.g., perceived usefulness and ease of use) generated by the users (Lu, et al., 2010; Lin & Chang, 2018; Yin & Lin, 2022). We hypothesize that interpersonal interactions increase a person's perceived value.

H1a: Human-human interaction positively affects individuals' perceived value toward real estate APP platforms.

2.5.2 Effects of human-information interaction of real estate APP on perceived value

Human-information interaction is defined as individuals actively searching for information about various services from intelligent machines and receiving responses (Lin & Chang, 2018; Zhao & Lu, 2012), and intelligent machines successfully providing information to individuals and receiving responses (Lee & Lee, 2019). Human-information interaction reflects the use of intelligent machines (e.g. social media sites, banking APPs, real estate APP, etc.) by individuals to access or share information (Ko et al., 2005; Zhao et al., 2012; Hsu et al., 2015; Wei et al., 2015). Studies have demonstrated that as the frequency of human-information interaction increases, the efficiency of online human interaction and intelligent information searching between individuals and intelligent machines also increases (Hsu et al., 2015).

Studies (Lu et al., 2010; Lin & Chang, 2018; Lee & Lee, 2019) have focused on the relationship between human-information interaction and perceived value. They have found that based on the powerful and advanced functions of intelligent machines, individuals can implement human-information interaction through commands such as select, search, edit, and modify, which not only helps users to search and browse information efficiently and quickly, but also effectively influences users to access information through intelligent machines to obtain perceived value. Yin & Lin (2022) discovered through their study of mobile banking APPs that human-information interaction positively influences the perceived value of users in terms of perceived usefulness, perceived ease of use, and perceived knowledge security. In a study by Lee and Lee (2019) to examine the determinants of ACG users' behaviour on social media, a conceptual model was developed to examine users' continuous intentions on ACG social media sites via the combination of perceived interactivity and users' intention to exchange information, the results confirmed that human-information interaction positively affects the users' perceived ease of use and usability by ACG social media sites. The study provided empirical evidence for the role of human-information interaction in influencing perceived value in terms of perceived ease of use and perceived usefulness of human-machine interaction. Thus, the present study expects that human-information interaction by real estate APP platforms induce perceived value with real estate APP platforms.

H1b: Human-information interaction by real estate APP platforms positively affects individuals' perceived value with real estate APP platforms.

2.5.3 Relationship between perceived value of real estate APP and individuals' psychological well-being

Psychological well-being primarily reflects the emotions of pleasure, elation and delight directly experienced by the individuals, and the assessment of satisfaction with life, oneself and social relationships based on the quality of life, and thus is viewed as a major variable of human optimal functioning in life (Ryff & Keyes, 1995; Ryff & Singer, 1998), becoming a predictive antecedent for positive personal development (Ryff, 2013; Chen et al., 2013), especially a consequence of high levels of perceived value. For example, in respect to full autonomy, environmental mastery, sense of purpose in life, and self-acceptance (Sagone & De Caroli, 2014; De Caroli & Sagone, 2016), perceived value is associated with all six dimensions of psychological well-being, which essentially indicates that high levels of self-acceptance, autonomy, personal growth, purpose, personal mastery, and positive social relationships are strongly connected to perceived gains and losses.

In fact, according to Day (1990) and Aurier et al. (2004), individuals evaluate the benefits provided by the real estate APP and the costs paid by the individuals when using it. In particular, perceived benefits and losses (i.e., perceived value) can motivate consumers to experience a well-being when individuals receive positive evaluation results. More precisely, the perceived value at the end of the use of the real estate APP can evoke a well-being in the consumer. Thus, perceived value supports the development of individuals' psychological well-being. The individuals' psychological well-being (i.e., self-esteem, balance, social commitment, sociability, control of self and of events, happiness) continuously improves with the level co-perceived value (e.g., utilitarian benefits, hedonic benefits). Abaidi et al. (2022) in a study examining the sources of consumers' psychological well-being found that co-production influences consumers' psychological well-being through perceived benefits and perceived value. The effect of the role of sources of psychological well-being is explained through an increase in perceived value, providing evidence from an empirical research perspective that perceived value affects consumers' psychological well-being. Thus, this study proposes the following hypothesis:

H2: Perceived value of real estate APP positively influences individuals' psychological well-being with real estate APP platforms.

2.5.4 The mediating role of perceived value toward real estate APP

According to Hapsari et al. (2016), as individuals' perceived interactivity in real estate APP deepen, the perceived value formed on the basis of the subjective and personalized evaluations individuals generate emotionally about the quality of real estate APP, services, etc., become a predictive variable for users' choice to use real estate APP (e.g. products or services), thus moving away from the previous behavioural basis of measuring the perceived value inspired by a real estate APP applications and transforming it into a psychological well-being. Perceived interactivity positively influences perceived value through the evaluation of perceived gains, perceived losses and the pleasure gained from using real estate APP, which in turn yields results in the psychological well-being. Perceived interactivity is a source of increased consumer psychological well-being, a fact that can be improved by human-human interaction through perceived value (mediating role 1), and human-information interaction through perceived value (mediating role 2), ultimately improving consumer psychological well-being.

On the one hand, people get additional pleasure and satisfaction from using real estate APP through self-expression, presentation and perceptual interaction with others (i.e. human-human interaction), thus creating a good emotional connection between the user and the real estate APP applications, which in turn enhances the perceived value (Lu, et al., 2010; Hsu and Lin, 2016; Lin & Chang, 2018; Yin & Lin, 2022). The purpose of psychological well-being involves primarily seeking pleasure and avoiding painful outcomes (White, 2006), and the fact that real estate APP satisfy users' basic value claims is the basis for their psychological well-being, as people continue to gain perceived value satisfaction from using real estate APP. The accumulation of users' perceived value of real estate APP affects the superposition of their psychological well-being, i.e. the source of users' psychological well-being is grounded in the perceived value of real estate APP. Thus, perceived value may be an important mediating variable in the transition from human-human interaction to psychological well-being. On the other hand, psychological well-being becomes more prominent due to the perception of benefits (Abaidi et al., 2022). Users can gain different values in using real estate APP through

human-information interaction (Lee & Lee, 2019; Yin & Lin, 2022), which leads to enthusiasm and intimacy for real estate APP and a continuous commitment of more time, energy and willingness to give personal resources and money to them.

This input ultimately reinforces the perceived value generated by the human-information interaction with real estate APP, creating a sense of intimacy and dependency, which in turn leads to a solid long-term psychological well-being. Perceived value may be an important mediating variable from human-information interaction to psychological well-being. The positive impact of perceived interactivity on psychological well-being mediated through perceived value is inconclusive in terms of empirical research. Studying the influence of perceived interactivity on perceived value contributes to the salience of perceived benefits in explaining psychological well-being. Thus, this study proposes the following hypothesis.

H3: Perceived value mediates the relationship between human-human interaction (H3a), human-information interaction (H3b) and individuals' psychological well-being with real estate APP platforms.

2.5.5 The moderating role of privacy concerns toward real estate APP

With the transformation and upgrading of the real estate industry, the changing habits of the public in choosing and buying properties, and the accelerated pace of work, real estate APP platforms must provide products and services that meet the public demand on the one hand, and counter the negative impact of the resulting privacy leakage on the other. Privacy concerns are gradually becoming a concern for real estate APP consumers. In fact, the real estate app platforms are not completely safe from privacy breaches, and user privacy breaches which are potentially risky can involve user identity theft, online fraud and information harassment. Usually, users want their personal information in real estate APP platforms to be in a secure state to prevent information leakage. Regarding the discussion of privacy concerns, prior studies have described privacy concerns as "anxiety about personal privacy" (Yun et al., 2019) and "concern about controlling access to and subsequent use of information about individuals" (Tan et al., 2012). Therefore, this study defines privacy concerns as users' awareness, evaluation and behavioural intention regarding the risk of privacy being violated or compromised in the context of real estate APP usage.

According to Cho et al. (2019), the individuals' privacy concerns are most highlighted salient when their interests are compromised. Therefore, negative issues involving perceived value related to perceived interactivity are occurring as a result of personal information leakage on real estate APP platforms, leading to personal privacy exposure. In other words, as users' privacy concerns about real estate APP platforms increase, the perceived interactivity created in HCI has a weaker effect on perceived value. In other words, as individuals' privacy concerns about real estate APP platforms increase, the perceived interactivity they create in HCI has a diminishing effect on perceived value. The converse is also true. This indicates that users who take privacy concerns very seriously expect stronger privacy protection during real estate APP usage to address anxiety and concerns about privacy breaches, which weakens the positive relationship between perceived interaction and perceived value. This study addresses the influence of perceived interactivity on users' perceived value through a privacy concerns perspective for finding the boundary conditions of privacy concerns in the mechanism of users' psychological well-being. In turn, this study provides valuable references for developers of real

estate APP platforms to improve HCI functions and promote marketing strategies, ultimately providing services that are more in demand by users of real estate APP platforms.

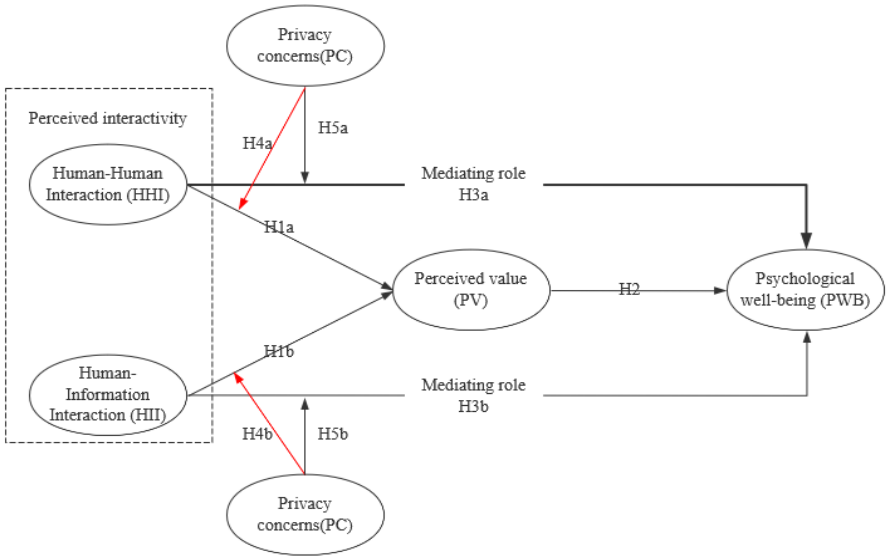
H4: Privacy concerns negatively moderate the relationship between perceived interactivity and user perceived value, i.e., the positive relationship between human-human interaction (H4a) and user perceived value and between human-information interaction (H4b) and user perceived value is weaker at high levels of privacy concerns by real estate APP platform than at low levels of privacy concerns.

This study further explores a moderated mediation model which anticipates that privacy concerns may also mediate the indirect effect of perceived interactivity on users' psychological well-being through perceived value (Edwards & Lambert, 2007). Specifically, perceived value mediates the indirect effect of perceived interactivity (i.e., human-human interaction and human-information interaction) on users' psychological well-being, and the magnitude of this mediating effect is influenced by privacy concerns. When individuals have higher levels of privacy concerns, perceived interactivity (i.e., human-human interaction and human-information interaction) is less likely to transmit or mediate the indirect effect of perceived value on users' psychological well-being through perceived value. In contrast, the indirect effect of perceived interactivity on users' psychological well-being via perceived value can be correspondingly higher when individuals' privacy concerns are lower. In sum, the following hypothesis is proposed.

H5: Privacy concerns negatively moderate the indirect effects of perceived interactivity (i.e., human-human interaction: H5a and human-information interaction: H5b) on users' psychological well-being through perceived value.

Several hypotheses between the constructs are proposed and in turn a theoretical model for this study with the support of a theoretical foundation and hypothesis discussion is proposed to test these hypotheses in a real estate APP context, as shown in Figure 1.

Figure I. Theoretical model



3 Method

3.1 Sample and procedure

The real estate APP is chosen for this investigation because of its use of advanced HCI technology, which can better demonstrate the promotional effect of perceived interactivity on consumers' psychological well-being under HCI technology. This study collaborated with a Beijing-based real estate agency, My Love Home, whose agents sent a link of the questionnaire to their consumers. Before the questionnaire was formally answered, consumers were asked to answer three filtering questions: Have you used a real estate APP recently? Are you satisfied with the service provided by the online human customer service of the real estate APP? Are you satisfied with the functional services offered by the real estate APP (e.g. VR viewing, VR buying)? These three questions were used to filter the subjects who met the requirements of this study. This is because these three filtering questions basically reflect consumers' perception and understanding of the perceived interaction between human and machine driven by the human-machine interaction of the real estate APP (e.g., interface operation, service application, service feedback processing, etc.).

In total, questionnaires answered by 618 participants were collected, some non-compliant ones were excluded to obtain a sample of 568 consumers. There were 251 males, slightly less than 311 females, with the largest number of consumers aged 18-29 (45.8%) and 30-39 (32.6%), followed by 78 consumers aged 40-49, and the smallest number (only 35) of consumers over 50. This is in line with the current reality in China, where young people are the main buyers of homes, with the majority of consumers in their 30s, since they are the main group of consumers facing marriage and thus buying a home. In terms of marital status, there was an equal proportion of married (275, 48.4%) and unmarried consumers (270, 47.5%), together with 23 divorced consumers. Of the total, 38.7% (220) had a university degree, 38.5% (219) had a postgraduate degree (including masters and doctorates), while 22.7% (129) had less than a university degree. This vividly reproduces the current face of consumers in China's big cities, i.e. young people who have finished university in big cities tend to stay and live and develop in big cities; these highly educated people become the major part of consumers, with most of them being undergraduates, who naturally become the main group of home buyers. Overall, the sample structure is consistent with reality.

3.2 Measures

All measures were derived from well-established scales that had been developed and validated in previous studies. Except for demographics and perceived value, all variables were scored using a 7-point Likert scale from 1 to 7 (1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neutral: neither agree nor disagree, 5 = slightly agree, 6 = agree, 7 = strongly agree). Specifically, for perceived value, participants indicated the extent to which they felt perceived gain, perceived loss, and pleasure from their interactions with the real estate APP (1 = Not at all, 7 = To a very large extent).

Psychological well-being. We adopted the scale validated by Ryff (1989), Clarke et al. (2001) and Andrew et al. (2012) to measure psychological well-being, which is a second-order construct composed of six sub-constructs (e.g., autonomy, personal growth, environmental mastery, positive relations, purpose in life, and self-acceptance) and three items each. The alpha reliability for this scale were 0.900, 0.920, 0.932, 0.933, 0.883, and 0.967.

Perceived Value. Just as with Jiang et al.'s (2016), this study measured perceived value using adapted versions of 5-item validated from Levesque and McDougall (1996). Sample items for perceived value include "Comparing what I pay to what I get, I think the company provided me with good value. "Alpha reliabilities for this scale was 0.803.

Perceived interactivity. Perceived interactivity is a multidimensional scale consisting of the human-human interaction and human-information interaction dimensions, and their variables are measured as follows.

Similar to Lee & Lee (2019) and Lin et al.'s (2017) work, we measured human-human interaction using 3 items from the Hsu et al. (2015) and Lin & Chang (2018) measure. A sample item for this scale is "I think the real estate APP applications makes it easy for me to communicate with human customer service." The alpha reliability for this scale was 0.955.

We used Lu et al. (2010), Hsu et al. (2015), Lin & Chang (2018) and Lee & Lee's (2019) 4-item scale to measure human- information interaction. A typical item for this scale is "I can efficiently use the real estate APP to search for real estate-related information." Alpha reliabilities for this scale was 0.916.

Privacy concerns. We used Tan et al. (2012), Son and Kim (2008) and Shin (2010) privacy concerns scales, which were modified into four measurement items in accordance with the back-translation method promoted by Cha et al. (2007), to evaluate users' privacy concerns mainly in the context of real estate APP. Alpha reliabilities for privacy concerns was 0.945.

Control variables. We included age, sex, education, income level, use frequency, and marriage as controls as some of these variables have been shown to be related, albeit weakly, with psychological well-being and perceived interactivity (Yang et al., 2022).

4 Data analyses

4.1 Outer model

For the analysis of convergent validity of the scales, standardized factor loadings, rhoA, average variance extracted (AVE) and composite reliability (CR) were calculated for all variables of the measurement scales. First, we analyzed the standardized factor loadings of the variables. For the perceived value scale, all questions met the requirements, except for question PV5, which did not meet the requirements. This was attributed to the fact that the standardized factor loadings of PV5 was equal to 0.049 and lower than 0.45. Hooper et al. (2008) argued that measurement questions with standardized factor loadings lower than 0.45 had excessive errors and should be deleted, so the question item PV5 was deleted in this study. As shown in Table I, after deleting question item PV5, the standardized factor loadings of all variables complied. Immediately after, we further analyzed the rhoA, AVE, and CR of the variables, and found that rho_A was greater than 0.7, AVE was greater than 0.5, and CR was greater than 0.7 (see Table 1 for details), all of which met the requirement of acceptable convergent validity (Hair et al., 1998; Hair et al., 2017).

Table I. Convergent validity

Variables	Items	Factor loadings	rho_A	CR	AVE
Human-human interaction	HHI1	0.901	0.955	0.971	0.918

	HHI2	0.935			
	HHI3	0.940			
	HII1	0.957	0.919	0.947	0.857
Human- information interaction	HII2	0.967			
	HII3	0.949			
	PV1	0.849	0.920	0.885	0.652
	PV2	0.922			
Perceived value	PV3	0.931			
	PV4	0.906			
	PV5	0.049			
	AUT1	0.902	0.903	0.938	0.834
Autonomy	AUT2	0.913			
	AUT3	0.924			
	PEG1	0.931	0.920	0.949	0.862
Personal growth	PEG2	0.938			
	PEG3	0.916			
	ENM1	0.931	0.932	0.957	0.880
Environmental mastery	ENM2	0.941			
	ENM3	0.942			
	POR1	0.937	0.933	0.957	0.882
Positive relations	POR2	0.942			
	POR3	0.938			
	PIL1	0.903	0.884	0.928	0.811
Purpose in life	PIL2	0.912			
	PIL3	0.886			
	SEA1	0.969	0.967	0.978	0.938
Self-acceptance	SEA2	0.970			
	SEA3	0.967			
	AUT1-3	0.842	0.967	0.967	0.624
	PEG1-3	0.737			
Psychological well-being	ENM1-3	0.924			
	POR1-3	0.921			

	PIL1-3	0.939			
	SEA1-3	0.711			
Privacy concern	PC1	0.904	0.946	0.96	0.858
	PC2	0.937			
	PC3	0.936			
	PC4	0.928			

Then, this study assessed the square root of each variable AVE and the correlation between the constructs to measure discriminant validity for the theoretical model. The assessment results indicated discriminant validity at an acceptable level (see Table II for details), given that all diagonal values (i.e., bolded values) were greater than the correlations between the constructs (Fornell & Larcker, 1981).

Table II. Discriminant validity analysis

	Mean	SD	1	2	3	4	5
1.Human-human interaction	3.242	1.695	0.926				
2.Human- information interaction	3.045	1.787	0.763	0.958			
3.Perceived value	3.695	1.670	0.383	0.358	0.807		
4.Psychological well-being	3.915	1.397	0.443	0.427	0.646	0.790	
5.Privacy concern	5.511	1.426	-0.467	-0.475	-0.336	-0.291	0.927

4.2 Inner model

Goodness of fit (GOF) indices were used to estimate the model fit of the proposed model. The calculation formula for GOF is as follows.

$$\mathrm{GOF} = \sqrt{\overline{\mathrm{AVE}} \times \overline{R^2}}.$$

Overall, the larger the GOF value, the better the model fit (Vinzi et al., 2010). Specifically, GOF values less than 0.1 indicate a weak model fit. GOF values between 0.1 and 0.25 indicate a low model fit, while GOF values between 0.25 and 0.36 indicate an acceptable model fit. GOF values above 0.36 indicate high model fit. The GOF value is 0.716 indicating the reasonable fit for the model. Moreover, the variance explained by perceived value was 15.6% and the variance explained by psychological well-being was 46.9%, indicating a good fit of the internal model. Human-human interaction ($\beta = 0.158$, $p < 0.01$) and human-information interaction ($\beta = 0.261$, $p < 0.001$) positively affects individuals' perceived value toward real estate APP platforms, respectively, which ($p < 0.001$) further affects individuals' psychological well-being with real estate APP platforms. Accordingly, supporting hypotheses 1a, 1b, and 2 (See Table III).

Table III. Hypotheses testing and path coefficient

Path	β	Standard Deviation	T Statistics	p	f^2	R^2	Supported
H1(a): Human-human interaction→Perceived value	0.158	0.068	2.331	**	0.034	0.156	Yes
H1(b): Human-information interaction→Perceived value	0.261	0.066	3.951	***	0.012		Yes
H2: Perceived value→Psychological well-being	0.548	0.036	15.183	***	0.478	0.469	Yes

Note. *** p < 0.001, ** P < 0.01

4.3 Mediating effect analysis

A mediation analysis was conducted following the guidelines set forth by Haye (2009) to examining whether perceived value is partially or fully mediated in the effect of perceived interactivity (i.e., human-human interaction and human-information interaction) on an individual's psychological well-being. The detailed analysis of the mediation effect is shown in Table IV. In perceived value mediating the relationship between human-human interaction and individuals' psychological well-being, the indirect effect, i.e., HHI→PV→PWB (β= 0.143, p<0.001) was significant; further analysis revealed that the direct effect, HHI→PWB (β= 0.138, p<0.001), was also significant. In perceived value mediating the relationship between human-information interaction and individuals' psychological well-being, the indirect effect, i.e., HHI→PV→PWB (β= 0.087, P<0.001) was significant; further analysis revealed that the direct effect, HHI→PWB (β= 0.126, P<0.001), was also significant. Moreover, according to the suggestion made by Haye (2009), if the relationship between HHI→PV→PWB was not significant, the mediating effect of perceived value should be interpreted as fully mediated. Otherwise, it should be interpreted as partially mediated. Consequently, perceived value partially mediated the beneficial effects of human-human interaction (H3a) on individuals' psychological well-being, and human-information interaction (H3b) on individuals' psychological well-being, respectively.

Table IV. The analysis of mediating effect

Path	Point Estimate	Product of coefficients			Bias-corrected 95%		Percentile 95%	
		S.E	Z-Value	P-Value	Lower bound	Upper bound	Lower bound	Upper bound
H3(a)Total effect: HHI→PWB	0.281	0.065	4.344	***	0.158	0.414	0.157	0.411

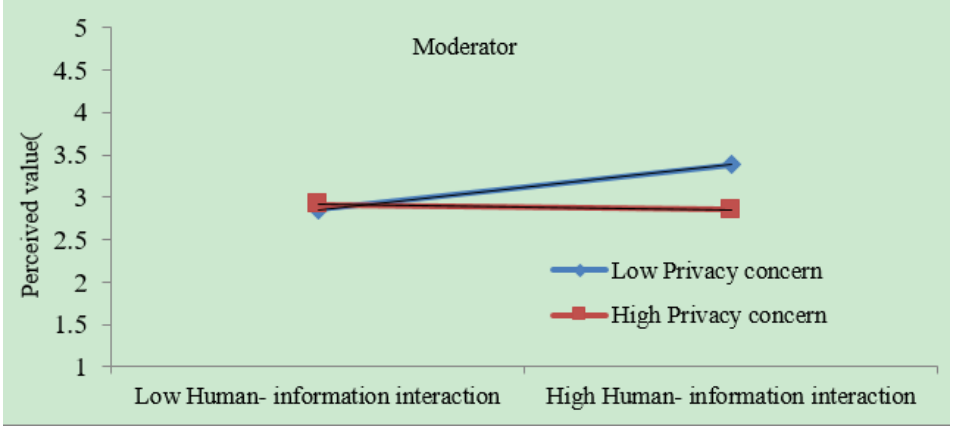
H3(a)Indirect effect: HHI→PV→PWB	0.143	0.039	3.684	***	0.073	0.224	0.077	0.231
H3(a)Direct effect: HHI→PWB	0.138	0.048	2.854	**	0.045	0.233	0.045	0.233
H3(b)Total effect: HII→PWB	0.213	0.063	3.352	**	0.080	0.332	0.082	0.333
H3(b)Indirect effect: HII→PV→PWB	0.087	0.038	2.264	*	0.012	0.159	0.012	0.159
H3(b)Direct effect: HII→PWB	0.126	0.045	2.781	**	0.034	0.214	0.034	0.214

Note. *** p < 0.001, ** P < 0.01, *P < 0.05. Human-human interaction=HHI, Human- information interaction=HII, Perceived value=PV, Psychological well-being=PWB.

4.4 Moderating effect analysis

Privacy concerns did not negatively moderate the relationship between human-human interaction by real estate APP platforms and user perceived value (β = 0.033, p = 0.646 ＞0.05), but negatively moderate the relationship between human-information interaction by real estate APP platforms and user perceived value (β= 0.147, p＜0.05), thus hypotheses 4a was not supported, while hypothesis 4b was supported. For H4b, the slope of human-information interaction on user perceived value increased negatively by 0.147 units for every 1 unit increased in privacy concerns, i.e. privacy concerns negatively moderated the relationship between human-human interaction by real estate APP platforms and user perceived value (see Figure 2). This implies that the positive relationship between human-information interaction and user perceived value is weaker at high levels of privacy concerns than at low levels of privacy concerns.

Figure II. Privacy concerns moderates the effect of human-information interaction on perceived value



4.5 Further analysis: moderated mediation model

For human-human interaction →perceived value→ psychological well-being, specific indirect effects-diff (H-L) = 0.030, p>0.05, thus not supporting moderated mediation, indicating that H5a was not supported. For human-information interaction →Perceived value→ Psychological well-being, specific indirect effects-diff (H-L) = -0.178, p<0.05, supporting

moderated mediation. Specifically, the moderating effect (b=-0.147, p<0.05) of privacy concerns affecting ''HII→PV'' was significant, and the moderating effect (b=-0.061, p<0.05) of privacy concerns affecting ''PV→PWB'' was significant (see Table V), thus the mediating interference effect holds, indicating that H5b was supported.

Table V. The analysis of moderated mediation

Effects		Human-human interaction→ Perceived value→ Psychological well-being	Human- information interaction →Perceived value→ Psychological well-being
Specific Indirect Effects-diff (H - L)		0.030	-0.178
t-Value(|H vs L|)		0.343	2.004
p-Value (H vs L)		0.732	0.046
Specific Indirect Effects (H)	Original	0.159	-0.040
Specific Indirect Effects (L)	Original	0.130	0.138
STDEV (H)		0.061	0.065
STDEV (L)		0.062	0.060

5 Discussion

This investigation supports positive relationship between human-human interaction and human-information interaction on individuals' perceived value (i.e., H1a and H1b are supported), which is consistent with the findings of Xiao et al. (2012), Ba & Wang (2013), Lin & Chang (2018), Yin & Lin (2022), and Lee and Lee (2019). The enhancement of HCI technology contributes to the increase of consumers' perceived value and stimulates consumers' responsiveness to perceived gains and losses. Although HCI may not always lead to good outcomes (i.e., perceived gains), it may also cause difficulties in consumer decision making, diminished sense of control, and elimination of effort (i.e., perceived losses) (André et al., 2018). The perceived interactivity empowered by real estate APP through HCI technologies is beneficial in driving consumers to be more likely to create more perceived value in human-human interaction and human-information interaction.

The result confirms the positive impact of perceived value by real estate APP on individuals' psychological well-being (i.e., H2 is supported), and the findings are consistent with those of Abaidi et al. (2022). This suggests that HCI promotes consumers to have more perceived value and gain stronger psychological well-being. The effective design and application of HCI technology in real estate APP promotes positive emotional experiences (e.g., information exchange and dialogue in interpersonal communication), which in turn evoke and reinforce consumers' self-esteem, balance, social commitment, sociability, control over self and events, and well-being. The more significant the consumer perceived value in HCI, the more it enhances the individuals' psychological well-being in HCI.

The mediating role of perceived value (i.e., H3 is supported), and our investigation are consistent with expectations. Perceived value partially mediates the relationship between human-human interaction and individuals' psychological well-being and human-information interaction and individuals' psychological well-being with real estate APP platforms, respectively. This suggests that the enhancement of consumer well-being by perceived interactivity created from human-machine interaction in real estate APP contexts is achieved through a mediating mechanism that stimulates consumers to acquire perceived value during human-machine interaction. Consumers with greater perceived value acquisition have more access to perceived usefulness, perceived ease of use, and perceived pleasure during HCI (Ryan & Deci, 2001), which in turn satisfies consumers' ability to seek control over perceived value and positive emotions, thereby enhancing individual psychological well-being.

The relationship between human-information interaction and perceived value is moderated by privacy concerns. On this foundation, it is further confirmed that the relationship between human-information interaction and individual psychological well-being with real estate APP platforms is moderated by privacy concerns through the indirect relationship of perceived value. In contrast, the relationship between human-human interaction by real estate APP platforms and perceived value is not moderated by privacy concerns, and the indirect relationship between human-human interaction and individual psychological well-being through perceived value is not moderated by privacy concerns. Specifically, the interaction between individuals in the real estate APP context and the real estate APP may be secure by the warm customer service, or individuals may not neglect the privacy risk by failing to pay enough attention to the information leakage in the human-human interaction, and thus are not negatively affected by the privacy concerns. In human-information interaction, individuals filter the information that is useful to them, and use privacy risk as a reference indicator to assess the usefulness of information. The effect of human-information interaction by real estate APP platforms on perceived value is weaker at high levels of privacy concerns than at low levels of privacy concerns. More importantly, the indirect effect of human-information interaction on users' psychological well-being by real estate APP platforms via perceived value is weaker at high levels of privacy concerns than at low levels of privacy concerns. The converse is also true.

5.1 Theoretical contributions

This study offers a novel perspective on the complex relationship between perceived interactivity and individuals' psychological well-being. We synthesize prior research on the relationship between perceived interactivity and individuals' psychological well-being, which has noted the influence of perceived interactivity on information technology and mobile information technology, and helped enhance users' online human interaction and intelligent information searching (Yin & Lin, 2022; Lee & Lee, 2019; Abaidi et al., 2022). However, prior studies are limited and findings have failed to draw consistent conclusions, and there is even less research on human-computer interactivity design adapted to real estate APP platforms. This study confirms the mechanism of perceived interactivity on real estate APP users' psychological well-being thus filling the gap and expanding the literature on perceived interactivity in the field of real estate APP research.

This study constructs and empirically analyzes a theoretical model in which perceived interactivity influences individual psychological well-being via perceived value by real estate APP

platforms. The study finds an indirect effect of perceived interactivity on psychological well-being (Tang & Zhu, 2019), a departure from prior findings. Although previous studies have confirmed the relationship between perceived interactivity with real estate APP platforms and perceived value, and the relationship between perceived value and psychological well-being, little exploration goes to the relationship between perceived interactivity and psychological well-being. The results of this study construct the mechanism of perceived interactivity driving psychological well-being through perceived value, which expands a novel perspective to study the formation mechanism of users' psychological well-being of real estate APP.

This study examines the moderating role of privacy concerns in the relationship between perceived interactivity affecting perceived value and the moderating role of privacy concerns in the indirect relationship between perceived interactivity and psychological well-being in real estate APP platforms. The results not only demonstrate that privacy concerns is a moderating variable between human-information interaction and psychological well-being, but further find that privacy concerns negatively moderates the indirect effect of human-information interaction on users' psychological well-being via perceived value. This study reveals the boundary conditions under which human-information interaction in perceived interactivity influences individual psychological well-being and provides important management insights for the further development of individual psychological well-being.

5.2 Practical implications

Real estate APP should pay full attention to the important role of HCI in real estate APP development and design, and adopt HCI technology to improve the level of user perceived interactivity of real estate APP platforms. Specifically, the real estate APP system is optimized in terms of interface design, content output and function design to increase HCI and response to consumer needs, and to improve the efficiency of consumer information search, dialogue and transaction. On the one hand, human-machine interaction is used to guide consumers' online search for information, to release the opportunity for consumers to obtain perceived value through perceived interactivity, to strengthen the human-human interaction in human-machine interaction, to drive consumers to respond to the relevant services of real estate APP customer service online, for example, through VR house search, house viewing and house selection, and then to bring consumers’ perceived value through the interaction between human and customer service or virtual robots. On the other hand, personalized recommendations are embedded into the real estate APP system, and personalized recommendations supported by artificial intelligence can help improve services, enhance human-information interaction and effectively use online personalized recommendation strategies such as "special offers", "new homes" and "second homes" to enhance consumers' perceived value.

Real estate APP should strengthen consumers' perceived value in HCI, and then increase consumers' psychological well-being. Modern information technology (e.g., artificial intelligence, chatbot, big data, block chain, etc.) is used to analyze consumer behavior, predict, identify and judge consumer needs and preferences, so as to continuously optimize consumer perceived usefulness, perceived ease of use and other values, and promote the acquisition of consumer perceived value. Real estate APP that focus only on the driving effect of technical features on consumer behavior do not positively influence consumer attitudes and purchase decisions (Huang & Rust, 2017). It is evident that HCI cannot be separated from consumers' need for

perceived value and the sense of well-being that comes from the interaction process. Perceived value is an important source of psychological well-being and happiness, and the perceived interactivity created by HCI brings perceived value (e.g., functional value, entertainment value and social value) to consumers and further influences the formation of consumers' psychological well-being. Therefore, it is necessary for real estate APP to use information technology to conduct in-depth analysis of user behavior, increase the matching degree between intelligent technology systems and user demands, consider their perceived value in design work, and thus enhance consumers' psychological well-being.

This result reduces the risk of privacy leakage in HCI, enhance consumer information security, and thus reduce the negative moderating effect of privacy concerns. Given that the indirect effect of human-information interaction on users' psychological well-being by real estate APP platforms through perceived value is weaker at high levels of privacy concerns than at low levels of privacy concerns, real estate APP should strive to find ways to reduce the negative effects of consumer privacy concerns on the relationship between human-information interaction by real estate APP platforms and perceived value. On the one hand, the real estate APP can use modern intelligent technologies to decipher consumer disclosure characteristics, gain insight into the specific reasons that trigger consumer privacy concerns, and analyze and address them according to the various sources that pose threats to consumer information security. On this foundation, real estate APP can effectively prevent and reduce consumer privacy leakage and privacy concerns triggered by HCI, thereby reducing the effect of weakening consumer perceived value and psychological well-being. On the other hand, real estate APP can use big data to accurately analyze consumer preferences, actively adjust products and optimize service contents according to consumer preferences, and then provide more perceived value for consumers. More importantly, more perceived value counteracts the negative effects of privacy risks and positively influences individuals' psychological well-being with real estate APP platforms.

5.3 Future research agenda

This study uses structural equation modeling to enhance understanding of the role of perceived interactivity in influencing individuals' psychological well-being. However, there are some weaknesses in this study and more research could be conducted on when and how perceived interactivity affects individuals' psychological well-being.

Future research should involve theoretically novel moderation variables. We designed and examined the moderating effect of privacy concerns. However, privacy concerns are only moderation factors considered from a perspective related to the context of perceived interactivity. Future research could consider assessing more complex moderating effects from an individual perspective. For example, male vs. female customers' responses to real estate APP, the need for perceived interactivity. In addition, future research needs to examine new moderators in terms of research design perspectives (e.g., real estate APP type).

Future study needs to consider theoretically meaningful mediation variables. This study uses perceived value as an important variable in the theoretical model, as suggested in the HRI literature, but this is limited to the mediators mentioned in the existing studies. Future research could try other meaningful mediators; for example, service quality, negative emotions, and other customer presentations. In addition, it would be interesting to evaluate serial mediation

in influence mechanisms of perceived interactivity affecting consumers' psychological well-being. For example, functional mediators impact on relational mediators due to the challenging value and innovative implications are for our structural equation model. These studies should also consider the curvilinear relationship between mediators and consumers' psychological well-being, although we have studied a linear relationship between perceived interactivity and consumers' psychological well-being. Perhaps considering novel mediation models would reveal a further curvilinear relationship between perceived interactivity and consumers' psychological well-being, thus extending the findings of existing research.

In addition, future studies need to consider using different research designs. This study is conducted through the questionnaire and does not measure the actual behaviour of participants. Future studies could consider using a longitudinal design and assess whether perceived interactivity has different effects on individuals' psychological well-being at different stages of using real estate APP. Future study could also draw customers from different types of real estate APP to examine contextual differences.

6 Conclusion

Employing the perceived interactivity theory, this study finds that influence mechanisms of perceived interactivity increase consumers' psychological well-being, the mediating role of perceived value and the moderating role of privacy concerns in the relationship between perceived interactivity and consumers' psychological well-being. The findings of this study provide preliminary but important empirical evidence on perceived interactivity increasing consumers' psychological well-being.

This study expects to systematically synthesize previous inconsistent findings on the relationship between perceived interactivity and individuals' psychological well-being, to explore and reveal the process mechanism about perceived interactivity increasing consumers' psychological well-being from the real estate APP research field, to provide important implications for the better understanding of individuals' psychological well-being differences, and to call for and stimulate future research to explore more about the effects of perceived interactivity on HCI technology, such as real estate APP.

Availability of data and materials: No authorized

Conflict of Interest: None

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