**Pay with a smile? Modelling the continuance use intention of facial recognition payment**

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## Abstract

**Purpose:** This study synthesises the self-determination theory (SDT), expectation-confirmation model (ECM), and protection motivation theory (PMT) to formulate an integrated theoretical framework that elucidates the process of shaping the intention to continue using facial recognition payment (FRP) under the conditional impact of perceived technology security.

**Design/method/approach:** Data from 667 Beijing Winter Olympics visitors with FRP experience were collected through an online survey and analysed using variance based-structural equation modelling (VB-SEM).

**Findings:** This study reveals that the intention to continue using FRP evolves through three key stages. Initially, in the expectation stage, the multidimensional concept of artificial autonomy (sensing, thought, and action), which is underpinned by self-determination, is pivotal, strongly influencing perceptions of service enhancement and fostering trust in FRP. Subsequently, the confirmation stage underscores the importance of perceived service enhancement and trust as vital drivers in maintaining FRP usage, while also contributing to subjective well-being. Crucially, perceived technology security emerges as a key moderating factor, enhancing positive perceptions and intentions towards FRP, thus influencing its sustained adoption.

**Originality:** This study stands out by revealing the nuanced interplay between artificial autonomy and user perceptions, particularly concerning service enhancement, technology security, and trust, as they influence well-being and the continued adoption of FRP. Robustly grounded in the integrated theoretical framework of SDT, ECM, and PMT, the study's findings are critical for comprehending the core elements and specific drivers that promote sustained FRP use, especially as we consider its potential widespread implementation. Therefore, this study not only advances theoretical understanding but also offers practical guidance for optimising FRP deployment strategies in a rapidly evolving technological landscape.

**Keywords:** Expectation-confirmation model; Self-determination theory; Protection motivation theory; Continuance use intention; Facial recognition payment; Smart payment.

## 1. Introduction

Long gone are the days when using cash or credit cards were the only options for payment. With contactless payments being preferred as a result of the COVID-19 pandemic, the transition to smart payment, particularly facial recognition payment (FRP), has accelerated rapidly. Using the face as the primary physiological trait in authenticating payment, FRP has driven the payment process to a new level of convenience, as users do not need to carry a smartphone, a credit card, or even have to enter a passcode (Liu *et al*., 2021; Maity *et al*., 2020). As one of the world's largest emerging economies, China is frequently showcased as one of the first movers in implementing FRP, most notably through payment giants such as Alipay's Smile to Pay, WeChat's Frog Pro, and UnionPay (LinkedIn, 2021; Jao, 2019). According to iiMedia Research (2019), more than a third of China's population (± 495 million) expressed their preference to use FRP to pay for their purchases. As technology advances, this new-age contactless and biometric payment system is expected to be widely accepted and used by the public in both developed and developing economies (Lee *et al*., 2023), such as Europe, Japan, South Korea, and the United States (ABI Research, 2020).

Compared to conventional payment systems, FRP uses biometric features to identify and measure face topography rapidly and precisely. By incorporating an artificial intelligence algorithm, the FRP system has the advantage of adjusting to lighting changes and allowing authentication from various angles. It also codes images and saves details in a database for greater efficiency, as the system can retrieve users' past transactions and process new transactions in seconds (Ciftci *et al*., 2021). With a non-obtrusive nature, this biometric identifier makes the checkout process more relaxed and user-friendly, as user images can be obtained quickly without physical contact (Lai and Rau, 2021). Following the users' preferences, these autonomy features are not only beneficial in elevating onboarding experiences, but also in functioning as an intelligent solution for companies that intend to offer users contactless and seamless shopping experiences (Gupta *et al*., 2023).

Studies attempting to understand the use of smart payment systems are on the rise, especially after the COVID-19 pandemic. Most studies concentrate on traditional smart payment systems such as electronic wallets, online banking, and mobile payment apps using theories such as diffusion of innovation (DOI), technology acceptance model (TAM), and unified theory of acceptance and use of technology (UTAUT) (e.g., Chakraborty *et al*., 2022; Lim *et al*., 2022; Sharma *et al*., 2022), but only a few studies focus on users' acceptability and post-consumption experiences toward FRP (Li *et al*., 2020; Moriuchi, 2021). This may be explained by the newness of facial biometric systems in the marketplace as fewer businesses have adopted such technology as compared to conventional systems (Lai and Rau, 2021).

To promote the sustainable growth of FRP, this study asserts the need for a deeper understanding of the factors contributing to the maturation of this modern smart payment system. In the information systems (IS) literature, there is a recognised discrepancy between initial behaviours (i.e., acceptance and initial use) and post-adoption behaviours (i.e., continued use). The initial step towards success is marked by the former (Shazad *et al*., 2024), while the latter is essential for ensuring long-term returns (Rasul *et al*., 2023). In practical terms, businesses must develop strategies to retain existing users, particularly when the cost of acquiring new users exceeds that of retaining existing ones (Lim, 2015). Against this background, the main motivation of this study is to explore the factors and dynamics influencing the perceptions of FRP users and their intentions to continue using FRP.

Numerous studies highlight the significance of integrating acceptance and motivational factors in technology design to cultivate user motivation, leading to favourable attitudes and desired behavioural outcomes. This study amalgamates the self-determination theory (SDT) (Ryan and Deci, 2000), expectation-confirmation model (ECM) (Bhattacherjee, 2001), and protection motivation theory (PMT) (Rogers, 1983) into an integrated theoretical framework for understanding FRP continuance behaviour. SDT probes into artificial autonomy and subjective well-being as essential motivational elements, ECM delineates the decision-making journey for FRP usage continuation, and PMT underscores protective behaviours in response to perceived risks. This triad of theories not only propels theoretical understanding but also shapes practical insights, setting the stage for an in-depth exploration of artificial autonomy, user perceptions and continuance intentions, and the nuanced role of technology security.

Firstly, this study delves into the concept of artificial autonomy as a key motivational factor, guided by the principles of SDT, to enhance users' perceptions of FRP. SDT, which emphasises the role of autonomy in fostering intrinsic motivation (Ryan and Deci, 2000), provides a theoretical underpinning for understanding how artificial autonomy can influence user adoption and interaction with smart systems (Hu *et al*., 2021). As defined by Rijsdijk and Hultink (2009, p. 26), autonomy refers to "the extent to which a product can operate independently and in a goal-directed manner without user interference." A system achieves intelligence when it possesses a higher degree of autonomy in processing data. While existing research suggests the examination of artificial autonomy in understanding intelligent system use, its consequences and downstream effects remain insufficiently explored (Hu *et al*., 2021). Building on the insights of Hu *et al*. (2021), this research conceptualises artificial autonomy across three dimensions—sensing, thought, and action autonomy—and investigates how the cumulative impact of artificial autonomy influences user perceptions of FRP. Given that the core objective of FRP is to enhance the efficiency and intelligence of payment processing, this investigation introduces artificial autonomy as a key ingredient of autonomous motivational factors. Furthermore, this research posits that artificial autonomy within FRP does not merely function as a technical enhancer of efficiency and intelligence but plays a pivotal role in the psychological interaction between users and technology. SDT underscores the importance of fulfilling individuals' innate psychological needs as a pathway to subjective well-being, characterised by a profound sense of contentment and psychological satisfaction (Lin and Windasari, 2019; Yu *et al*., 2018). In this vein, the current study critically examines the mechanisms through which artificial autonomy intersects with SDT principles to amplify subjective well-being, positing that the sophistication of artificial autonomy in FRP—by attenuating uncertainties through service enhancement and bolstering trust—serves as a catalyst in transforming user experiences. This transformation, we argue, is not merely functional but deeply psychological, fostering a sense of autonomy among users. By doing so, artificial autonomy in FRP could transcend conventional boundaries, contributing not just to perceived service enhancement and trust but to a more profound, psychological state of well-being among users. This investigation is not only timely but essential, as it fills a significant gap in our understanding of the psychological dimensions of technological interactions and their implications for user-centric design and innovation in financial technologies.

Secondly, this study explores how user continuance use intentions can be shaped. Anchored in the principles of ECM (Bhattacherjee, 2001), the study proposes that autonomous motivation, specifically the sense of artificial autonomy derived from FRP usage, plays a pivotal role in cultivating positive user expectations in the initial stage, and as users progress, their opinions towards FRP performance evolve from the point of expectation to the point of confirmation. Within this study, two pertinent variables are introduced to gauge user perceptions during the confirmation stage. To attract and retain users, service providers must transcend basic characteristics and employ effective strategies, such as emphasising the benefits and value of FRP. This emphasis is reflected in perceived service enhancement, a concept extensively explored in service research and identified as a crucial pillar for promoting a positive response to service innovation (Belanche *et al*., 2021). Simultaneously, prior research underscores the substantial impact of users' emotions on their decision to sustain interaction with a service provider (Ashraf *et al*., 2021). Positive user feelings towards a service often lead to a high intention for frequent usage and the development of a long-term relationship with the service provider. In response, this study incorporates trust as another pivotal factor that reflects users' emotional responses during interactions with FRP. Trust is conceptualised as the belief that the other party will adhere to appropriate behaviour (Wu and Tang, 2022). To further underscore the importance of how user continuance use intentions are shaped in FRP, this research examines the potential positioning of perceived service enhancement, trust, and subjective well-being as sequential mediators in enhancing the connection between artificial autonomy and post-adoption behaviour.

Finally, in our extended inquiry, guided by the principles of PMT, which posits that individuals exhibit protective behaviours in response to perceived threats (Rogers, 1983), we delve deeper into the ramifications of perceived technology security in FRP. PMT is particularly relevant in discerning whether technological security serves as a deterrent factor, influencing the restrained adoption of FRP. In particular, our study aims to highlight a pressing and emerging issue which is the necessity for a thorough comprehension of how users navigate security concerns in the evolving landscape of FRP. This landscape is marked by increasing autonomy, complexity, intractability, and opaqueness (Lim, 2023; Rahwan *et al*., 2019) of smart payment. Although FRP algorithms have the potential to enhance service quality, our study raises a consequential drawback: the suboptimal onboarding experience for new users. Industry surveys underscore the dual impact of FRP, providing convenience to users while also presenting threats to data security alongside personality, portrait, and property rights (Liu, 2019). This duality aligns with the fundamental principles of the PMT (Rogers, 1983), asserting that individuals inherently manifest protective behaviours and engage in countermeasures in response to perceived risks. Hence, we introduce perceived technology security as a conditional factor, providing a novel perspective on how security threats can influence users' inclinations to either continue or discontinue using FRP. This nuanced exploration not only offers theoretical clarity of complex relationships but also carries practical implications for system developers of FRP. As a result, these findings are expected to provide a foundation for tailored recommendations that strike a balance between the potential benefits of FRP with the need for robust security measures.

## 2. Theoretical foundation

### *2.1 Self-determination theory (SDT)*

To analyse the distinct characteristics that differentiate FRP systems from traditional payment methods, this study adopts SDT, which is one of the most widely used theories for exploring motivational factors that influence users' intentions to adopt various technologies. Arghashi and Yuksel (2022, p. 3) stated that 'motivational factors' are crucial in predicting technology adoption. According to SDT, individuals are more likely to be intrinsically motivated to adopt an innovation when their fundamental needs are met (Ryan and Deci, 2000). This theory has been widely used to understand the motivations (or deterrents) to using various emerging technologies in recent times, including AI-powered conversational agents (Jan *et al*., 2023), anti-food waste apps (Cassia and Magno, 2024), and travel-tracking apps (Medeiros *et al*., 2022), among others.

To comprehend the use of FRP, it is crucial to emphasise the impact of autonomous motivation. Artificial autonomy, which includes action, sensing, and thought autonomy, aligns seamlessly with the focus on autonomy in SDT and is considered one of the most critical attributes for evaluating the effectiveness of AI-based innovations. Artificial autonomy refers to a system's ability to perform tasks previously done by humans without explicit assistance (Parasuraman *et al*., 2000). The level of autonomy is considered higher when the system can execute a larger portion of tasks with minimal human intervention. In the case of FRP, users' motivation is heightened when this innovation is embedded with a high degree of artificial autonomy. Specifically, the system's ability to process biometric features, including detection (e.g., scanning the face), analysis (e.g., assessing the data), and recognition (e.g., verifying the information), can contribute to users' autonomous motivation. This characteristic is a crucial success factor in shaping positive user expectations toward FRP, particularly when users experience the benefits of the biometric authentication system during check-out (Moriuchi, 2021). To conceptualise the application of artificial autonomy, this study uses three taxonomies: action, sensing, and thought to elaborate on how well FRP performs various aspects of its task.

*Action autonomy* entails an artificial system's ability to interact autonomously with significant elements in its environment, such as managing applications or devices, processing or verifying user data, and authenticating payment procedures (Pianca and Santucci, 2023). This form of autonomy ideally positions FRP to represent its users and fulfil their requests effectively.

*Sensing autonomy* pertains to an artificial system's ability to perceive and interpret its environment independently. Within FRP, sensing autonomy is crucial, encompassing the system's proficiency in actively and accurately acquiring sensory data, such as scanning users' faces or gauging their expressions (Formosa, 2021).

*Thought autonomy* relates to an artificial system's ability to accurately address users' queries without requiring human intervention (Müller, 2012). This feature is crucial in providing personalised and precise suggestions that align with users' preferences and requirements.

Moreover, SDT delves into the dynamics between the fulfilment of individuals' intrinsic needs—such as autonomy, competence, and relatedness—and the alignment of these needs with their personal aspirations and values (Ryan and Deci, 2000). This alignment is posited as a cornerstone for fostering a deep-seated sense of subjective well-being. The critical role of this theoretical linkage in understanding the motivational underpinnings of technology adoption and its subsequent impact on users' psychological states has been cogently discussed by Yu et al. (2018) and further elaborated by Buzinde (2020). These discussions underscore the importance of considering subjective well-being not merely as a peripheral outcome but as a central element in the adoption and sustained use of technological innovations, including FRP. This perspective encourages a re-evaluation of technology adoption models (Lim, 2018), urging them to integrate well-being as a fundamental metric alongside traditional measures of efficiency and utility.

Given this discussion, this study integrates the multidimensional concept of artificial autonomy as a key autonomous motivation variable and positions the concept of subjective well-being as a critical evaluative motivation. This strategic integration allows the study to delve into how the initial expectations of artificial autonomy contribute to the satisfaction and subsequent confirmation of those expectations through the lens of subjective well-being. By examining the interplay between these constructs, this study illuminates the ways in which users' perceptions of FRP evolve as they transition towards the confirmation stage, as delineated by ECM. This approach not only enriches understanding of technology adoption dynamics but also underscores the significance of subjective well-being as an essential, yet often overlooked, dimension in the evaluative processes underpinning user satisfaction and technology acceptance.

### *2.2 Expectation-confirmation model (ECM)*

The expectation-confirmation model (ECM) is a cognitive model that explains the cognitive processes individuals undergo when making decisions related to IS continuance (Bhattacherjee, 2001). The model investigates the long-term factors that support the reuse of the system. This theory has been applied in IS studies examining users' satisfaction and intention to continue using various innovations, including cryptocurrency (Arpaci, 2023), digital payment (Bhatia *et al*., 2023; Franque *et al.*, 2023), and electronic banking (Rahi *et al*., 2023). Bhattacherjee (2001), the founder who proposed the process, delineates that users forming continuance intention undergo three core stages: expectation, confirmation, and continuance (commonly used post-adoption behaviour).

*Expectations*, in the context of FRP, refer to pretrial beliefs about the payment system. These beliefs, shaped by anticipated behaviour, serve as benchmarks against which the system's performance is assessed (Yang *et al*., 2023). Initial expectations about FRP are established before its first use, with prior experience and existing knowledge leading to more realistic expectations. However, a lack of first-hand experience may result in expectations derived from alternative sources, such as feedback from existing users, opinion leaders, media reports, or marketing initiatives (Wolverton *et al*., 2020). Regardless of their source, these initial expectations provide benchmarks for evaluating the future performance of FRP.

*Confirmation* or *disconfirmation* judgement is formed when individuals compare perceived performance to their initial expectations, forming a confirmation judgment (Meng-Lewis *et al*., 2024). There are three potential outcomes that may arise at this stage: negative disconfirmation, positive disconfirmation and simple confirmation (Mishra *et al*., 2023; Oliver, 1980). Negative disconfirmation happens when actual performance falls short of expectations, while positive disconfirmation happens when actual performance exceeds expectations. Simple confirmation takes place when actual performance aligns with expectations.

*Post-adoption behaviour* encompasses the actions and decisions individuals make after utilising a specific information system, software, or technology. The examination of post-acceptance behaviour (i.e., continued use) is considered more influential than pre-acceptance behaviour (i.e., intention to use) for the following reasons: From the demand side, post-acceptance behaviour, particularly the assessment of continuance use intention, holds greater significance as compared to pre-acceptance measurements like intention to use because pre-acceptance measures are based on perceptions, while post-acceptance behaviour reflects the tangible actions of users. Moreover, users who are willing to continue using IS can play a crucial role in influencing potential future users. Their positive feedback and recommendations can create a ripple effect, shaping the perceptions and decisions of those considering its adoption. From the supply side, the potential for higher revenues through an upsurge in persistent usage by satisfied users, wherein continued and increased use by this demographic contributes to greater returns.

While ECM exhibits notable strengths, particularly in elucidating IS continuance behaviours (Gupta *et al*., 2020), it is considered somewhat parsimonious as it primarily focuses on three general constructs (i.e., expectations, confirmation, and continuance) and overlooks important context-based variables. Recognising this limitation, Bhattacherjee (2001) in his revised work acknowledged the imperative to enhance the model for a more comprehensive understanding of continuance intention. To fill this gap, a growing body of research underscores the necessity of expanding ECM by incorporating additional contextual factors. Studies have shown that the explanatory power of continuance use intention significantly improves when ECM incorporates supplementary variables (Oghuma *et al*., 2016; Tam et al., 2020). These findings highlight the significance of adopting a broader perspective that incorporates context-based considerations to achieve a more nuanced and accurate portrayal of users' behavioural continuance patterns. Therefore, this study endeavours to expand ECM, offering a more comprehensive and holistic framework for comprehending and predicting user behaviours when using FRP.

### *2.3 Protection motivation theory (PMT)*

The core tenet of the PMT posits that individuals take proactive measures or engage in specific behaviours to mitigate perceived threats, wherein these threats primarily originate from a convergence of information inputs, encompassing verbal communication, observational learning, and past experiences (Rogers, 1983). Expanding the application of PMT to the individual level, researchers have extensively employed it to understand how individuals protect themselves in online security behaviours (Al-Balushi *et al*., 2024) and the usage of personal device security (Chennamaneni and Gupta, 2023; Skalkos *et al*., 2024).

In the context of utilising a smart payment device, an individual's threat appraisal is activated if they perceive a vulnerability to the potential loss of personal data (Alalwan *et al*., 2024). This critical juncture prompts individuals to engage in a cognitive process that involves a cost-benefit analysis (Hijazi and Abudaabes, 2023). They carefully weigh the risks associated with non-protective behaviour against the costs involved in mitigating these risks. Through this analysis, people make a conscious decision whether to continue or discontinue the use of the smart payment device.

To further explore this outcome, this research employs PMT to elucidate the potential impact of perceived technology security on altering FRP usage. Perceived technology security refers to users' potential concerns regarding the safety and security of transactions and data shared over a platform when using a technology (Oliveira *et al*., 2016). Pagani and Malacarne (2017) argue that users' perception of technology security can be categorised into two main types: security intrusions by companies attempting to obtain and use personal information for marketing purposes, and security intrusions involving spammers, viruses, and pirates. Drawing from related literature (Nguyen *et al*., 2021; Zhong *et al*., 2021), this study posits that although users may have a favourable attitude when using FRP, perceived technology security holds a significant influence on those who are reluctant to use FRP due to security concerns.

## 3. Conceptual foundation and hypotheses development

### *3.1 Expectation stage: artificial autonomy*

The relationship between artificial autonomy and its ability to act as an independent motivator for improving perceived service quality in FRP is supported by SDT. SDT suggests that autonomous motivation is crucial in shaping a positive user experience (Ryan and Deci, 2000). In the context of FRP, heightened autonomous motivation arises from the system's precision in executing transactions seamlessly without human intervention across three dimensions: sensing, thought, and action (Talluri *et al*., 2013). For example, a heightened level of sensing autonomy in FRP reinforces the system's automation and contactless transaction nature (Hu *et al*., 2021). As users approach the payment terminal, the system recognises their facial features automatically, without requiring any explicit actions. This frictionless and straightforward payment process significantly enhances user convenience, contributing to an elevated perception of service quality (Zhou, 2014). Additionally, the system provides a substantial degree of thought autonomy, guiding users through the payment process and offering intuitive and intelligent transaction services. By providing relevant and tailored recommendations, the payment process can become more efficient (Al-Maliki and Al-Assam, 2021). This is consistent with prior studies on online banking, which highlight the importance of personalisation in enhancing the perceived quality of service provided by intelligent service systems (Zhang *et al*., 2023). Furthermore, FRP systems with high levels of autonomy ensure precise transaction execution, resulting in a seamless and efficient service experience for users (Talluri *et al*., 2013). Based on these observations, this study suggests that artificial autonomy is crucial in enhancing the positive service perception associated with FRP. This leads us to propose the following hypothesis:

**H1a**. Artificial autonomy positively impacts perceived service enhancement in FRP.

This study also extends the hypothesis based on the foundational principles of SDT, positing that the establishment of trust in utilising FRP is fundamentally linked to the fulfilment of autonomous motivation. Building on previous research, a payment system with significant autonomy in its actions has features that make payment transactions more intuitive, reliable, and less prone to errors, thereby fostering trust among users (Liébana-Cabanillas *et al*., 2019; Zhao *et al*., 2018). For instance, a high level of sensory autonomy enables users to have control over the collection and utilisation of sensory data within FRP. Empirical findings indicate that when users perceive control over the accumulation of sensory data, their privacy sentiment is positively influenced (Halji and Lin, 2016). This assurance of judicious data management in accordance with user preferences catalyses heightened trust in the technology (Le *et al*., 2022). Similarly, a high degree of thought autonomy indicates the system's proficiency in offering relevant and valuable advice to FRP users. In the IS field, the competence of a smart service system in tailoring responses to individual preferences is recognised as pivotal in fostering trust during human-computer interactions (Nwankpa and Datta, 2022). Essentially, when users feel that they have control over the system's feedback, their trust in both the system and the underlying technology is strengthened. Stemming from these observations, we posit the following hypothesis:

**H1b**. Artificial autonomy positively impacts trust in FRP.

### *3.2 Confirmation stage: perceived service enhancement*

The optimisation of services constitutes the delivery of superior experiences that instil a sense of value among users (Chang *et al*., 2022a). This perception plays a pivotal role in fostering the adoption of innovative technologies, providing companies with a strategic rationale for integrating cutting-edge systems into their regular operations (Wang *et al*., 2022). Drawing specific parallels to online banking, Geebren et al. (2021) noted that emerging banking systems, characterised by commendable service precision, are more adept at meeting user expectations and consequently elevating their overall life quality. It follows that the perceived enhancement of services through FRP usage could also have a positive impact on users' subjective well-being.

The inherent convenience and efficiency of FRP, exemplified by the seamless execution of transactions through facial scans, have the potential to alleviate user frustration, eliciting positive emotions and amplifying the sense of well-being (Aboelmaged *et al*., 2021). Additionally, the system reduces cognitive burden by eliminating the need for password recall or PIN entry, resulting in a more streamlined and enjoyable payment experience. Hence, FRP grants users greater control over their financial transactions, merging cutting-edge technology with transactional autonomy. This newfound autonomy is associated with increased contentment and happiness, further bolstering subjective well-being. Furthermore, the refined user experience offered by FRP, particularly resonates with technology enthusiasts, can evoke positive sentiments, contributing to the overall enhancement of an individual's well-being (Henkens *et al*., 2020). Taking these conclusions into account, the study hypothesises:

**H2a.** Perceived service enhancement positively impacts users' subjective well-being in FRP.

Previous research has highlighted the significance of delivering superior services to build trust in target markets, thereby laying a robust foundation for the enduring success of cutting-edge systems in financial exchanges (Wünderlich *et al*., 2013; Zhang *et al*., 2021). However, there remains a noticeable research gap regarding the relationship between perceived service enhancement and users' sustained intention to use new payment mechanisms, particularly FRP. To bridge this gap, this study argues that perceived service enhancement directly fosters continued FRP utilisation, drawing on four key empirical insights.

Firstly, users are inclined to enjoy a superior experience when they perceive that FRP surpasses alternative payment modalities in terms of convenience, ease of use, and speed. According to Venkatesh *et al*. (2003), a positive user experience enhances enjoyment and satisfaction, leading to a positive attitude towards the technology and encouraging continued usage. Secondly, it is pivotal to acknowledge the various functional merits that are encompassed within perceived service enhancement, such as enhanced dependability, efficiency, and precision. As posited by Liébana-Cabanillas *et al*. (2014), acknowledging these benefits strengthens trust in the technology's prowess, propelling its sustained adoption. Thirdly, FRP's inherent straightforwardness and cognitive unburdening lead to cognitive ease, which fosters a favourable service perception. In agreement with this, Köse *et al*. (2019) argue that cognitive ease guides user views on technology usability, promoting its continued use. Lastly, perceived service enhancement can amplify the enjoyment of technology usage. This is consistent with TAM (Davis *et al*., 1992), which suggests that enjoyable interactions with technology can lead to increased intrinsic motivation for continued engagement. In alignment with these insights, the study proposes the following hypothesis:

**H2b.** Perceived service enhancement positively impacts continuance use intention of FRP.

### *3.3 Confirmation stage: trust*

Considering that users are both thinkers and feelers who use both cognitive and affective processing in deciding whether to adopt something, in this case, FRP, this study conceptualises trust as a high-order construct, entailing cognitive and emotional trust (Shi *et al*., 2021; Wu and Tang, 2022). Cognitive trust pertains to the user's confidence in, and willingness to rely on, a service provider. This arises from rational reasoning and evaluation when a focal partner is perceived as competent, meeting the user's obligations consistently (Johnson-George and Swap, 1982). In contrast, emotional trust relates to users' faith in an entity, rooted in the care and concern demonstrated by the service provider (Wu and Tang, 2022). It embodies more instinctual feelings and the depth of a relationship with a focal partner, with heightened emotion fostering a favourable attitude towards technology adoption (Gursoy *et al*., 2019; Wu and Tang, 2022).

Conventionally, IS research posits trust as a subjective assurance that augments future behaviour (Leong *et al*., 2022). Such trust can dilute psychological reservations tied to digital transactions (Shazad *et al*., 2024). As Chakraborty *et al*. (2022) assert, if users are convinced that a system can reliably render the expected services, they are inclined to harbour positive sentiments towards it, potentially enhancing their quality of life. Extending this thought to FRP, if users are assured that their biometric data is robustly safeguarded and exclusively used for payment verification, it can alleviate anxieties around potential data violations, cultivating positive subjective well-being. Simply put, if users feel they exert control over the payment mechanism and can seamlessly fine-tune their preferences, it may foster a heightened sense of autonomy, boosting their subjective well-being (Zhong and Mitchell, 2012). Building upon this logic, this study anticipates that consistent and smooth performance by FRP will bolster user trust, positively influencing their subjective well-being. Hence, the forthcoming hypothesis is postulated:

**H3a.** Trust positively impacts users' subjective well-being in FRP.

Bhattacherjee's (2001) ECM solidified the idea that amplified levels of trust correlate with heightened intentions to persist with a technology. In the context of mobile payment systems, trust holds pivotal sway over users' resolutions to remain on these platforms. For instance, Lim *et al*. (2022) unearthed in their study on e-wallet adoption that users' continuance intentions were profoundly moulded by their trust in the system's security and dependability. Shao *et al*. (2019) empirically underscored, in a Chinese context, that customers' perceptions of a trustworthy mobile payment platform positively shaped their continuance intentions. With regard to FRP, trust functions as a risk mitigator, influencing users' decisions to sustain its use. When users perceive FRP as trustworthy and confident in its reliable performance and data protection, this foundational trust augments their positive perceptions of the technology. This, in turn, steers their intentions to persist with FRP. On this premise, the next hypothesis is set forth:

**H3b.** Trust positively impacts continuance use intention of FRP.

### *3.4 Subjective well-being*

Innovations are likely to foster a high level of subjective well-being when users can experience positive affection (e.g., happiness, satisfaction) following their adoption (Diener, 1984). Noteworthily, a person experiencing a high level of subjective well-being is likely to exhibit continuance usage, as they tend to perceive that the innovation improves their lives (Yoon, 2014). This can be explained by the logic that people may be swayed more by emotional rather than rational responses (Kim and Shin, 2015). Despite this concept continuing to receive attention in IS research, research on the consequences of subjective well-being from the use of smart payment systems remains emerging and scarce. In a recent study, Lim *et al*. (2022) observed that users of electronic wallets that offered benefits such as low cost and personalised services are more likely to display a higher level of well-being (or maximise user pleasure) and exhibit a greater intention to continue using that payment method. By extension, the current study proposes subjective well-being as a salient driver that significantly affects FRP's continued usage. With the integration of biometric authentication into the payment system, the employment of FRP can improve the intelligence and efficiency of user data processing, with the system allowing users to "show their face" and leave thereafter. This system is expected to improve the lives of users and arouse their interest to continue using FRP. Therefore, the following hypothesis is proposed:

**H4.** Users' subjective well-being positively impacts continuance use intention of FRP.

### *3.5 Sequential mechanism: perceived service enhancement, trust, and subjective well-being*

The aforementioned hypotheses indicate three sequential mediations involving perceived service enhancement, trust, and subjective well-being on the relationship between artificial autonomy with the continuance use intention of FRP. These sequential mediations are articulated and supported with nuanced rationales from extant literature.

First, service enhancement is a significant consideration for users, particularly in adopting an innovation. Providing consistent and reliable services with minimal errors are core factors for service providers to gain a competitive advantage (Lu *et al*., 2019). Several studies have advocated the possibility that perceived service enhancement may influence user judgments of banking services, and users who perceive that the quality of service is superior may reciprocate with a profound level of loyalty (Chang *et al*., 2022b; Twum *et al*., 2023). It is, therefore, plausible that service enhancement may serve as an underlying mechanism for improving the relationship between FRP features and continued usage.

Second, existing research suggests that user experience is a key influencing factor in explaining and predicting why people continue or discontinue using a particular intelligent technology (Javornik *et al*., 2022). Generally, if users consider the adoption journey to be pleasant, they will show a high level of satisfaction with the technology's functionality, resulting in continuance use intention (Fang *et al*., 2021; Lim *et al*., 2022). This study postulates that the impact of FRP features on continuance usage is significantly determined by subjective well-being, in which users who perceive a higher degree of pleasure when using FRP are more likely to appreciate the system and use it for transactions.

Third, trust is another important element in understanding how people continue using certain technologies, as it plays an important role in reducing uncertainty (Shazad *et al*., 2024). For smart payment systems, trust reassures users of a stable relationship with the service provider and ensures that they will continue on the same platform instead of switching to others (Geebren *et al*., 2021). In this regard, this study proposes trust as a mechanism in the relationship between artificial autonomy and the continuance usage of FRP.

Taken collectively, these rationales support the formation of the following hypotheses:

**H5.** The relationship between artificial autonomy on the continuance use intention of FRP is sequentially mediated by perceived service enhancement and subjective well-being.

**H6.** The relationship between artificial autonomy on the continuance use intention of FRP is sequentially mediated by trust and subjective well-being.

### *3.6 Conditional effect: Perceived technology security*

Perceived technology security holds significance in the initial acceptance and continued adoption of electronic or smart payment technologies, as individuals naturally prefer secure channels for monetary transactions, ensuring the protection of their financial information. This aligns with previous studies showing that perceived technology security motivates the use of technology for managing monetary transactions (Duan and Deng, 2022; Lim *et al*., 2022). Specifically, online transaction technologies with a high level of perceived technology security are believed to protect users from potential financial losses and security threats, enhancing users' trust and subjective well-being (Lim *et al*., 2022). This became particularly evident during the COVID-19 pandemic, where social distancing measures increased reliance on FRP for effective and efficient monetary transactions, thereby reinforcing the significance of perceived technology security.

Considering this discussion, we posit that perceived technology security significantly strengthens the sequential mediators of trust and subjective well-being between artificial autonomy and the intention to continue using FRP. These hypotheses are presented as follows:

**H7.** Perceived technology security moderates the sequential mediators of perceived service enhancement and subjective well-being between artificial autonomy and continuance use intention of FRP, such that the sequential mediating effect is strengthened when perceived technology security is high.

**H8.** Perceived technology security moderates the sequential mediators of trust and subjective well-being between artificial autonomy and continuance use intention of FRP, such that the sequential mediating effect is strengthened when perceived technology security is high.

### *3.7 Control variables*

In this study, age, gender, education level, marital status, and prior experience in using FRP are used as control variables to avoid spurious explanations in our proposed hypotheses (Figure 1). As noted in IS literature, female and highly educated users from a young age are often technology savvy (Lim *et al*., 2022). Additionally, single individuals generally have lower financial commitments and thus have higher risk tolerance in trying new payment technology and a lower fear of monetary loss (Ratchford and Ratchford, 2021). Individuals who are more familiar with or have experience with comparable technologies, such as face recognition, are more likely to continue using the system (Lim *et al*., 2021).

[Insert Figure 1 here]

## 4. Methodology

### *4.1. Instrumentation*

A questionnaire was developed with items measuring the demographic and research variables. All items were modified based on reliable scales and rated on a seven-point Likert scale, with a higher value indicating stronger agreement (Appendix A). Artificial autonomy was captured using three dimensions (i.e., action, sensing, and thought autonomy) and the scale was adapted from Hu *et al*. (2021). Items for perceived technology security were adapted using the scale suggested by de Luna *et al*. (2019). Items for perceived service enhancement were adapted using Belanche *et al*.'s (2021) scale, while trust was specified as a reflective-formative second-order construct that captures two dimensions (i.e., cognitive and emotional trust), as suggested by Shi *et al*. (2021). The items in Kim and Hall's (2019) study were used to measure subjective well-being, whereas the items suggested by Yang and Jolly (2009) were used to assess continuance use intention.

### *4.2. Ethics, pre-test, and pilot study*

The university's ethics committee approved the questionnaire and sampling procedures prior to data collection. To minimise the error of the survey, the questionnaire was pretested by a panel of experts, thereby establishing content validity. Following that, a total of 50 respondents with FRP experience were invited to a pilot study, thereby establishing face validity. Some items were refined for greater clarity based on the feedback received at the pre-test stage before proceeding to the pilot study, and the same process ensued for the pilot study before progressing to the main study.

### *4.3. Context of study*

To test the proposed hypotheses, we surveyed international visitors who attended the Beijing Winter Olympics in 2022. This mega-event was selected because it was equipped with futuristic technologies such as FRP to provide a transformative user experience. In addition, China ranks among the top in Bloomberg's 2020 innovation rankings for upper-middle-income economies (Li *et al*., 2022a; World Intellectual Property Organization, 2021) and has a high degree of openness in testing and adopting new technologies (Hsu *et al*., 2018). A structured questionnaire was developed to collect data from international visitors who joined the event between 4 February 2022 and 20 February 2022, and had experience in using FRP more than three times when making purchases (i.e., food and beverages, souvenirs) during the mega-event. With the practice of social distancing, respondents were asked to scan the QR code to access the survey via Wenjuanxing (www.wjx.cn), one of the largest online survey platforms in China.

### *4.4. Sampling and procedures*

To address common method bias (CMB) and bolster confidence in our hypothesis outcomes, we adopted a time-lagged strategy over three waves, spaced a week apart (Figure 2). In the first wave, we collected data for three dimensions of artificial autonomy (i.e., action, sensing, and thought autonomy) and the moderator (i.e., perceived technology security), whereas data for perceived service enhancement, trust, and subjective well-being, as well as the outcome variable (i.e., continuance use intention) was collected in the second and third waves, respectively.

[Insert Figure 2 here]

Initially, 1,200 visitors who met the criteria were invited to the survey. All visitors were informed that their participation would be anonymous and voluntary, and that they could leave the survey at any time without consequences. In the first wave (4 February 2022), 1,000 respondents returned the survey (response rate of 83.33%). For the second wave (11 February 2022) and third wave (18 February 2022), the total returned responses were 850 (85% response rate) and 667 (78.47% response rate), respectively. From the 667 valid responses received, the majority of respondents were female (55.92%), single (57.12%), aged between 18 to 25 years (41.53%), held a bachelor's degree (77.21%), lacked prior experience in using facial recognition technology (64.77%), and were from the United States (21.29%) (Table 1).

[Insert Table 1 here]

## 5. Results

The data was first analysed using SPSS to assess demographic profiles and CMB. Hypothesis testing was then conducted using variance based-structural equation modelling (VB-SEM) via SmartPLS4 (Cheah *et al*., 2024; Hair *et al*., 2022). VB-SEM is recognised as a quasi-technique in IS research that is useful for maximising the variance explained in latent dependent variables (Lim *et al*., 2022; Song *et al*., 2021). We employed VB-SEM for three reasons. First, VB-SEM aligns with our research goals, which lean towards theory-building rather than purely confirmatory purposes, as it is adept at testing and exploring models (Shiau *et al*., 2019). Second, past research underscores VB-SEM's proficiency in handling complex variables, particularly higher-order constructs. For instance, artificial autonomy and trust in our study are conceptualised as reflective-formative types of higher-order constructs (Becker *et al*., 2023). Moreover, Cheah *et al*. (2021) found that VB-SEM excels in assessing research models populated with numerous constructs and complex relationships, such as the conditional mediation effect of perceived technology security. Third, VB-SEM outperforms its counterparts when the research goal is predictive or exploratory (Hair *et al*., 2022), characteristics that resonate with our study (Shmueli *et al*., 2019).

### *5.1 Common method bias (CMB) evaluation*

Significant measures were implemented to mitigate CMB. Procedurally, the survey offered precise contextual details on the cover page, provided clear instructions to clarify uncertain or ambiguous terms, assured respondents of their anonymity to alleviate discomfort or apprehension, and sourced data from multiple intervals (MacKenzie and Podsakoff, 2012). Importantly, our focus was on existing users of FRP, aiming to enhance the validity of their responses.

We undertook three statistical assessments to test for CMB: Harman's single factor test (MacKenzie and Podsakoff, 2012), the full collinearity test (Kock and Lynn, 2012), and the unmeasured latent method construct (ULMC) test (Chin *et al*., 2012). Harman's single-factor test showed that the variance explained by the first factor was 38.927%, below the threshold value of 40%. The full collinearity test indicated variance inflation factors (VIFs) between 2.040 and 3.297 (Table 2), well within the acceptable limit of 3.3, suggesting CMB is not problematic in this study (Kock and Lynn, 2012). For the ULMC, detailed in Appendix B, all substantive loadings were significant, with most method loadings being insignificant or holding minimal values, barring exceptions for TA1, PTS1, PSE2, PSE4, PSE5, CT2, and CUI2. The variance ratio between substantive and method was a significant 94.10:1, further confirming CMB was not an issue. Collectively, these tests assured that CMB did not pose concerns for our study.

### *5.2 Measurement model evaluation*

As part of the measurement model evaluation, the study's constructs were examined through Cronbach's alpha (α), rho_A, composite reliability (CR), and average variance extracted (AVE) (Hair et al., 2022). First, convergent validity and reliability were affirmed. As shown in Table 2, all items achieved loadings above the minimum threshold of 0.708 (Hair *et al*., 2022), whereas rho_A and CR exceeded the minimum benchmark of 0.70 while AVE surpassed the minimum 0.50 threshold (Hair *et al*., 2022). Second, discriminant validity was confirmed. As reported in Table 3, Fornell and Larcker's (1981) test shows that the square root of AVE for all constructs was higher than the correlations across all construct pairings. Moreover, the HTMT values for all constructs were below the 0.85 ceiling (Henseler et al., 2015). Overall, both discriminant validity tests were established and further confirmed by cross-loading results in Appendix C.

[Insert Table 2 and Table 3 here]

Third, artificial autonomy and trust—were specified as Type 2 reflective-formative higher-order constructs and assessed using the procedures outlined by Becker et al. (2023). In the initial step, global items for both artificial autonomy (i.e., Overall, the FRP technology can independently complete my payment transaction without human intervention.) and trust (i.e., Overall, I trust the use of face recognition payment.) were developed and assessed. The redundancy analysis result achieved a path coefficient value of 0.871 and 0.850, which are above the minimum threshold of 0.70 (Hair *et al*., 2022), confirming convergent validity. The VIF results were found below the maximum threshold of 3.3 (Table 4), signifying that the dimensions were distinct. In the final step, the statistical significance of both dimensions of trust was confirmed ($p < 0.01$) (Table 4). Thus, convergent and discriminant validity were established.

[Insert Table 4 here]

### *5.3 Structural model evaluation*

As part of the structural model evaluation, collinearity was unlikely to be an issue because the VIF values were lower than the maximum threshold of 3.33 (Hair *et al*., 2022). Since time-lagged data (i.e., Time 1 to Time 3) was used in our study, the Durbin-Watson (D-W) test was employed to identify the occurrence of autocorrelation in our dataset (Watson and Durbin, 1951). As presented in Table 5, no autocorrelation was detected as the D-W value fell within the range of 1.903 to 1.931 (nearing 2.0). Additionally, the direct relationship results revealed that artificial autonomy was found to have significant influences on perceived service enhancement (H1a: $\beta = 0.657$, t = 26.010; $p < 0.01$) and trust (H1b: $\beta = 0.648$, t = 27.023; $p < 0.01$). Thus, H1a and H1b were supported with an explanatory power of 43.1% and 42.0%.

Furthermore, both perceived service enhancement (H2a: $\beta = 0.197$, t = 6.561; $p < 0.01$, $f^2 = 0.375$) and trust (H3a: $\beta = 0.689$, t = 25.541; $p < 0.01$, $f^2 = 0.614$) were found to have significant influences on subjective well-being with a large effect size. Thus, H2a and H3a were supported and these relationships explained 68.3% of the variance in subjective well-being. Moreover, this study also found that perceived service enhancement (H2b: $\beta = 0.172$, t = 4.765; $p < 0.01$, $f^2 = 0.041$), trust (H3b: $\beta = 0.116$, t = 2.445; $p < 0.01$, $f^2 = 0.023$), and subjective well-being (H4: $\beta = 0.599$, t = 11.280; $p < 0.01$, $f^2 = 0.345$) exhibited positive and significant effects on continuance use intention, especially after controlling the effects of age, gender, education level, marital status, prior experience of using FRP, which were not significant. It was also noted that subjective well-being produced a large effect on continuance use intention compared to the small effect sizes of both perceived service enhancement and trust. Overall, these relationships explained 67.0% of the variance in continuance use intention and provided significant support to H2b, H3b and H4.

[Insert Table 5 here]

Next, PLSpredict was used to assess the predictive relevance of the structural model. The $Q^2$_predict values for perceived service enhancement (0.424), trust (0.413), subjective well-being (0.403), and continuance use intention (0.367) were greater than zero (Table 5), demonstrating the predictive relevance of the model (Shmueli et al., 2019). Subsequently, we looked at more precise prediction findings to focus on the endogenous items (Shmueli *et al*., 2019). Table 6 indicates that all endogenous items of the key target endogenous construct, by means of continuance use intention, possessed strong predictive power. In particular, the $Q^2$_predict values for the indicators of the Partial Least Squares (PLS) model outperformed those generated for the linear model (LM) ($Q^2$ values > 0), while all root mean squared error (RMSE) values for the PLS model were smaller than those of the LM model (Shmueli *et al*., 2019). To corroborate the result from PLSpredict, this study assessed the cross-validated predictive ability test (CVPAT) that offers a more comprehensive inferential test for the predictive model in predicting all endogenous items and constructs simultaneously (Sharma *et al*., 2023). Based on Table 6, our proposed model has stronger predictive power than indicator average and linear model benchmarks. Therefore, it was established that the proposed model has a strong predictive ability to represent a new observation of the target population.

[Insert Table 6 here]

### *5.4 Sequential mediation evaluation*

To assess the sequential mediating effects, we used the bootstrapping approach suggested by Hayes (2022). Based on Table 5, perceived service enhancement and subjective well-being sequentially mediate the relationship between artificial autonomy and continuance use intention (H5: $\beta = 0.078$, $t = 5.506$; $p < 0.01$). While trust and subjective well-being sequentially mediate the relationship between artificial autonomy and continuance use intention (H6: $\beta = 0.267$, $t = 10.113$; $p < 0.01$). Taken collectively, the results signal that the sequential mediators of trust and subjective well-being were statistically significant and played a stronger role than that of perceived service enhancement and subjective well-being (in terms of β) in promoting the relationship of artificial autonomy on continuance use intention of FRP (Table 5).

### *5.5 Moderated mediation evaluation*

We embarked on the moderated mediation procedure using PLS-SEM estimation (Cheah *et al*., 2021) to examine whether perceived technology security strengthened or weakened the sequential mediating effects of artificial autonomy on continuance use intention. As indicated in Table 7, the moderated mediation index supports both H7 and H8, as the p-value is below 0.05 and the confidence interval excludes zero.

Exploring these effects further, the standardised beta values of the moderated sequential mediation effect for perceived service enhancement and subjective well-being as well as trust and subjective well-being escalate from low to high perceived technology security levels. For H7 and H8, both ends of confidence intervals remain positive, signifying the significance of perceived technology security effects across all levels: low, medium, and high. These findings highlight the importance of considering varying levels of perceived technology security when contemplating the sequential mediation effect of perceived service enhancement and subjective well-being as well as trust and subjective well-being in enhancing the relationship between artificial autonomy and continuance use intention of FRP.

[Insert Table 7 here]

## 6. Discussion

This study aimed to expand the theoretical applicability of SDT, ECM, and PMT to the post-adoption behaviour of FRP. In doing so, the study presented new evidence on the impact of artificial autonomy on perceived service enhancement and trust towards FRP. Importantly, the continued use intention of FRP is positively influenced by three key factors: perceived service enhancement, trust, and subjective well-being. These findings are consistent with conclusions drawn in the post-adoption literature on mobile payments. Our results also indicate that perceived service enhancement, trust, and subjective well-being collectively serve as important sequential mediators in explaining the relationship between artificial autonomy and continuance use intention of FRP. This understanding is further enhanced through the identification of conditional mediation effects. Specifically, FRP features prove effective in generating positive outcomes (i.e., perceived service enhancement, subjective well-being, and trust) on continuance use intention, but only when perceived technology security of FRP is high. Hence, this study contributes significantly as it is the first to comprehensively explore the roles of sequential mediators and the moderator in FRP, grounded in the integrated theoretical frameworks of SDT, ECM, and PMT. Consequently, this study provides numerous theoretical and practical contributions, which will be discussed in the following sections.

### *6.1 Theoretical implications*

This study contributes significantly to existing knowledge in several ways. Firstly, the study expands the theoretical applicability of SDT by elucidating the crucial role of autonomous motivation in heightening users' expectations regarding the adoption of a new payment system. While the concept and function of artificial autonomy have garnered attention with the incorporation of autonomy features in AI artifacts like FRP, its substantial impact on predicting user experiences under such circumstances remains underexplored. Building on the recommendations of Hu *et al*. (2021), our study evidence that the artificial autonomy of FRP, associated with three task primitives—action, sensing, and thought—is a key factor in enhancing users' expectations. As anticipated, users have expressed positive expectations, particularly in perceived service enhancement and trust, when using FRP, which operates with high autonomy and intelligence (H1a and H1b supported). These findings align with the conclusions of Hu *et al*. (2021), affirming that artificial autonomy is a fundamental feature that reflects the AI device's ability to perform tasks effectively without human assistance, thereby providing users with an extraordinary experience.

Secondly, this study addresses an important theoretical question in the literature by providing evidence on the "what" and the "how" of the underlying mechanisms predicting continuance use intention through three stages (i.e., expectation, confirmation, and post-adoption behaviour) as outlined in ECM. From the direct relationship findings, we confirmed the importance of both perceived service enhancement and trust in influencing users' subjective well-being (H2a and H3a supported). This implies that users would only experience a high level of subjective well-being when they perceive that FRP is reliable and provides excellent service as compared to conventional payment systems. These results are consistent with previous studies, which reported that an efficient and capable mobile banking system that provides accurate services helps to enhance the quality of life of users, while a low-risk platform increases user subjective well-being (Chakraborty *et al*., 2022; Geebren *et al*., 2021). Apart from this, our study has shown that perceived service enhancement, trust, and subjective well-being are three vital factors influencing users' post-adoption (i.e., continuance use intention) with FRP (H2b, H3b, and H4 were supported). These results suggest that users' final decisions to continue or discontinue the use of the innovation are subject to the benefits they obtained (Lim, 2018; Javornik *et al*., 2022).

Thirdly, by pinpointing two sets of sequential mediation roles of perceived service enhancement and subjective well-being as well as trust and subjective well-being in the relationships between artificial autonomy and continuance use intention (H5 and H6 supported), this study contributes to the scarce literature on FRP and the theoretical generalisability of ECM in a new context. This contribution echoes the view of IS studies by opening the black box on how artificial autonomy influences post-adoption behaviour (Li *et al*., 2022b), thereby enriching our understanding of the necessary conditions for creating a strong linkage between FRP features and desirable results.

Lastly, the study's most noteworthy contribution arguably lies in the conditional factor of perceived technology security, which moderates the sequential mediators in the use of FRP (H7 and H8 supported). In doing so, we provide a more nuanced understanding that the relative contributions of artificial autonomy in promoting continued use (through a combined effect of perceived service enhancement, trust, and subjective well-being) depend on users' perceived technology security when interacting with FRP. In simpler terms, the findings highlight a crucial insight for future research: the provision of a payment system with high autonomy is more effective in enhancing users' perceptions of service delivery, trust, and well-being, subsequently on continuance use when they perceive a higher level of security during usage. This is in line with the fundamental principle of PMT (Rogers, 1983) and previous findings suggesting that although many users have a favourable attitude towards innovations, a significant number are reluctant to use them regularly due to security concerns (Nguyen *et al*., 2021; Zhong *et al*., 2021). Consequently, these findings provide a plausible explanation for why FRP continues to grapple with unresolved security issues, despite its design intent to provide enhanced benefits in everyday transactions (Liu *et al*., 2021)

### *6.2 Practical implications*

With the growing maturity of FRP, service providers must identify the essential factors that are relevant and optimise the usage among existing users. Service providers should recognise the prominent effect of artificial autonomy to raise service quality and enhance user beliefs cognitively and emotionally. In the context of FRP, artificial autonomy can be distinguished by three autonomous features: action, sense, and thought. Sensing autonomy can be improved by updating the system promptly to ensure that FRP can accurately recognise user facial expressions without manually entering relative information. Since FRP technology uses both AI and deep learning algorithms to classify data, thought autonomy can be improved by ensuring that the system can provide users with reliable and responsive recommendations without human intervention. It is also crucial that service providers always improve algorithms to increase the action autonomy of FRP (e.g., processing biometric data with fewer errors to entice users to continue using the technology). All of these are critical considerations to assemble a comprehensive artificial autonomy for FRP, because the use of FRP involves monetary transactions, and thus, any transaction error would result in a loss of user confidence and damage to the reputation of service providers.

Our findings also imply that service providers need to improve service performance as well as engender users' trust and subjective well-being to facilitate post-adoption usage of FRP. Strategies that can be implemented to provide FRP users with a smooth and compelling experience, for instance, is to ensure that the payment process is fun, efficient, and effortless. This will encourage users to believe in the ability and responsiveness of FRP, thereby encouraging them to continue using that technology.

Moreover, service providers should also pay close attention to both cognitive and emotional trust when driving desirable responses. The findings have shown that, in addition to providing a well-designed interface, it is also important that service providers try to meet the needs of users, for instance, ensuring that they interact with FRP in comfortable and satisfactory ways. Improving various aspects of human functioning, such as positive emotions, happiness, and making lives easier, is another aspect that should not be neglected to ensure the continued usage of FRP. Service providers are encouraged to use videos to illustrate the benefits of using FRP for both new and existing users. For example, they can show in their promotional videos how these payment options facilitate the creation of a healthier and safer shopping environment, streamline operations, and optimise sales opportunities, especially during pandemics like COVID-19.

Lastly, service providers must enhance user security control and alleviate concerns about security risks in the payment process using FRP. To achieve this, providers should provide additional levels of security options, such as incorporating the ability to enter a password in the payment interface. To prevent users and visitors from abandoning FRP due to security concerns, it is recommended to implement an isolated screen baffle to safeguard personal data. Additionally, it is essential to deploy FRP in highly controlled environments and regularly upgrade them with corresponding risk control systems (Piper, 2019). Government agencies are responsible for designing effective strategies and policies to safeguard user personal data from unauthorized access and illicit use. Collaborative efforts between government agencies and service providers are crucial to educate users and visitors about the robust security systems underpinning FRP, thereby mitigating potential concerns or resistance.

## 7. Conclusion

### *7.1. Key takeaways*

This study provides new insights by examining how artificial autonomy in FRP can affect several facets of user perceptions and behavioural decisions. Supported by SDT, ECM, and PMT, the results showed that users who experience high artificial autonomy (or autonomous motivation) when using FRP have a greater ability to navigate perceived service enhancement, trust, and subjective well-being that contribute to continuance use intention of FRP. The study also deepened our understanding that FRP with strong perceived technology security can strengthen the sequential mediation relationships (perceived service enhancement and subjective well-being; trust and subjective well-being) between artificial autonomy and continuance use intention. For researchers, this study provides a basis for further understanding the post-adoption behaviour of FRP using SDT, ECM, and PMT. Providing powerful artificial autonomy in FRP should enhance user service experiences, build trust, and generate positive outcomes that improve their standard of living. Finally, to increase the desire for continuance use, FRP must become a versatile and secure option for users when making any kind of payment.

### *7.2. Limitations and future research directions*

Notwithstanding the significant theoretical and practical implications of this study, several limitations exist, which may pave the way for future research. Firstly, our study sheds light on people's perceptions and behaviours toward FRP, especially those who attended the Beijing 2022 Winter Olympics, a majority being athletes aged 18 to 35 years. This specific demographic makes it challenging to extrapolate findings to different contexts like banks (Nguyen *et al*., 2021), smart retail stores (Moriuchi, 2021), or other mega-events (e.g., Coachella Valley Music and Arts Festival, Paris 2024 Summer Olympics, world expositions). Thus, future research should investigate various FRP scenarios, both physical and virtual, to enhance our model's robustness and generalisability. This is pivotal for elevating operational efficiency and risk management in today's digital age. Secondly, while we accounted for many relevant variables, the findings might still be enhanced by some unexplored moderators. Future research can incorporate both prevention and promotion perspectives to delve into the conditional mediation model (Lim *et al*., 2021). Such factors may shape the interplay between artificial autonomy's effects and continuance use decision-making. Lastly, as the "metaverse" gains traction globally (Kraus *et al*., 2023), Meta Pay, a metaverse-based payment system, emerges as a potential payment frontier that allows users to preload virtual debit cards with unlimited cryptocurrencies (Kumar *et al*., 2024). Exploring user acceptance or intent towards innovative payment systems like Meta Pay will be a valuable avenue for upcoming research.

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Figures

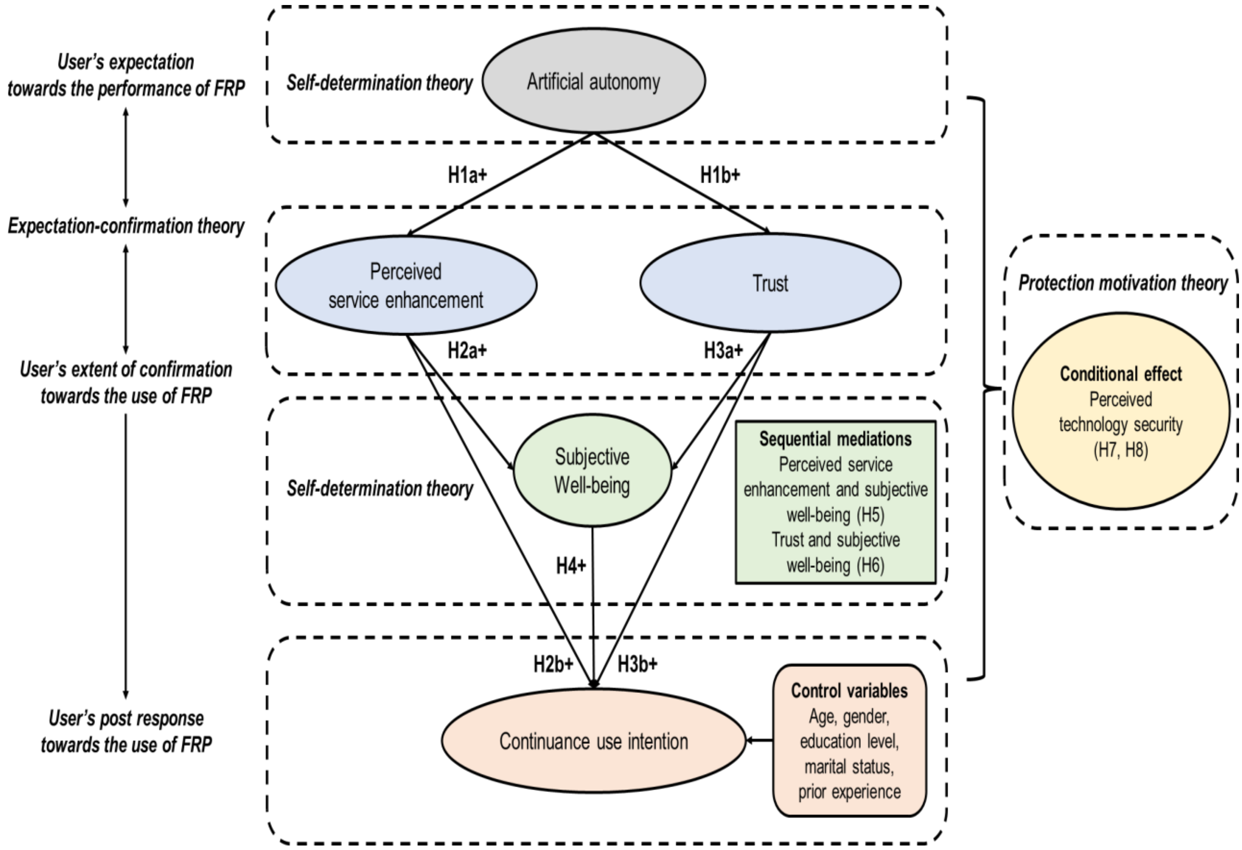


**Figure 1.** A self-determination, expectation-confirmation, and protection motivation theory for facial recognition payment (FRP)

**Source:** Authors' own illustration

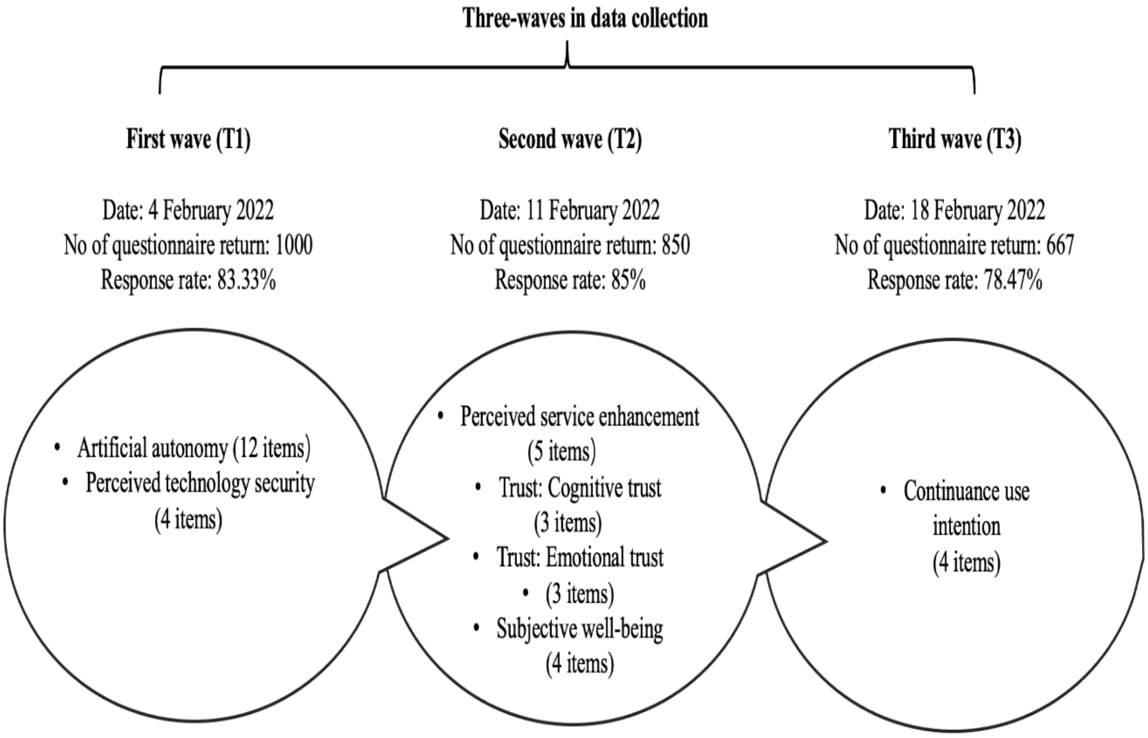


**Figure 2.** Three-waves data collection

**Source:** Authors' own illustration

# Tables

**Table 1.** Demographic profile of survey respondents

| Demographic | Category | $n$ = 667 | % |
|---|---|---|---|
| Age | 18 to 25 years | 277 | 41.53 |
| | 26 to 29 years | 221 | 33.13 |
| | 30 to 35 years | 169 | 25.34 |
| Education level | Bachelor’s degree | 515 | 77.21 |
| | Master’s degree | 135 | 20.24 |
| | Doctorate degree (e.g., DBA/PhD) | 17 | 2.55 |
| Gender | Female | 373 | 55.92 |
| | Male | 294 | 44.08 |
| Marital status | Single | 381 | 57.12 |
| | Married | 286 | 42.88 |
| Nationality | Canada | 113 | 16.94 |
| | Germany | 96 | 14.39 |
| | Italy | 69 | 10.34 |
| | Japan | 25 | 3.75 |
| | Sweden | 63 | 9.45 |
| | Switzerland | 119 | 17.84 |
| | United States | 142 | 21.29 |
| | Others | 40 | 6.00 |
| Do you have any prior experience of using facial recognition technology? | Yes | 235 | 35.23 |
| | No | 432 | 64.77 |

**Source:** Authors’ own illustration

**Table 2.** Assessment of reliability, convergent validity, and full collinearity

| Construct | Item | Loading | CA | rho_A | CR | AVE | FC |
|---|---|---|---|---|---|---|---|
| Action autonomy (AA) (T1) | AA1 | 0.897 | 0.917 | 0.917 | 0.941 | 0.800 | 2.040 |
| | AA2 | 0.884 | | | | | |
| | AA3 | 0.906 | | | | | |
| | AA4 | 0.891 | | | | | |
| Sensing autonomy (SA) (T1) | SA1 | 0.870 | 0.887 | 0.887 | 0.922 | 0.747 | 2.110 |
| | SA2 | 0.879 | | | | | |
| | SA3 | 0.868 | | | | | |
| | SA4 | 0.840 | | | | | |
| Thought autonomy (TA) (T1) | TA1 | 0.840 | 0.886 | 0.886 | 0.921 | 0.745 | 2.141 |
| | TA2 | 0.883 | | | | | |
| | TA3 | 0.871 | | | | | |
| | TA4 | 0.859 | | | | | |
| Perceived technology security (PTS) (T1) | PTS1 | 0.938 | 0.946 | 0.947 | 0.961 | 0.861 | 3.275 |
| | PTS2 | 0.930 | | | | | |
| | PTS3 | 0.916 | | | | | |
| | PTS4 | 0.926 | | | | | |
| Perceived service enhancement (PSE) (T2) | PSE1 | 0.780 | 0.879 | 0.882 | 0.912 | 0.674 | 2.156 |
| | PSE2 | 0.831 | | | | | |
| | PSE3 | 0.836 | | | | | |
| | PSE4 | 0.816 | | | | | |
| | PSE5 | 0.841 | | | | | |
| Trust: Cognitive trust (CT) (T2) | CT1 | 0.898 | 0.880 | 0.881 | 0.926 | 0.806 | 2.541 |
| | CT2 | 0.904 | | | | | |
| | CT3 | 0.892 | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Trust: Emotional trust (ET) (T2) | ET1 | 0.925 | 0.915 | 0.915 | 0.946 | 0.854 | 3.093 |
| | ET2 | 0.917 | | | | | |
| | ET3 | 0.930 | | | | | |
| Subjective well-being (SWB) (T2) | SWB1 | 0.907 | 0.928 | 0.929 | 0.949 | 0.822 | 3.297 |
| | SWB2 | 0.926 | | | | | |
| | SWB3 | 0.923 | | | | | |
| | SWB4 | 0.869 | | | | | |
| Continuance use intention (CUI) (T3) | CUI1 | 0.934 | 0.938 | 0.939 | 0.956 | 0.844 | 3.256 |
| | CUI2 | 0.925 | | | | | |
| | CUI3 | 0.923 | | | | | |
| | CUI4 | 0.892 | | | | | |

Note(s): T1 = Time 1. T2 = Time 2. T3 = Time 3. CA = Cronbach's alpha. CR = Composite reliability. AVE = Average variance extracted. FC = Full collinearity.

**Source:** Authors' own illustration

**Table 3.** Assessment of discriminant validity

| Construct | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Action autonomy (AA) (T1) | ***0.895*** | 0.622 | 0.614 | 0.447 | 0.558 | 0.494 | 0.454 | 0.517 | 0.521 |
| 2. Sensing autonomy (SA) (T1) | 0.689 | ***0.864*** | 0.598 | 0.508 | 0.574 | 0.550 | 0.535 | 0.557 | 0.544 |
| 3. Thought autonomy (TA) (T1) | 0.682 | 0.674 | ***0.863*** | 0.497 | 0.567 | 0.587 | 0.497 | 0.572 | 0.520 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4. Perceived technology security (PTS) (T1) | 0.480 | 0.554 | 0.543 | ***0.928*** | 0.535 | 0.672 | 0.783 | 0.782 | 0.733 |
| 5. Perceived service enhancement (PSE) (T2) | 0.619 | 0.647 | 0.641 | 0.582 | ***0.821*** | 0.578 | 0.579 | 0.627 | 0.621 |
| 6. Trust: Cognitive trust (CT) (T2) | 0.550 | 0.622 | 0.665 | 0.735 | 0.655 | ***0.898*** | 0.703 | 0.688 | 0.573 |
| 7. Trust: Emotional trust (ET) (T2) | 0.495 | 0.594 | 0.552 | 0.844 | 0.644 | 0.782 | ***0.924*** | 0.791 | 0.708 |
| 8. Subjective well-being (SWB) (T2) | 0.561 | 0.613 | 0.630 | 0.841 | 0.690 | 0.761 | 0.842 | ***0.907*** | 0.789 |
| 9. Continuance use intention (CUI) (T3) | 0.562 | 0.597 | 0.570 | 0.777 | 0.680 | 0.630 | 0.764 | 0.843 | ***0.919*** |

Note: The HTMT (< 0.85) result falls below the diagonal value; Values that are in bold and italic represent the result of the square root of the AVE values, while the above result belongs to inter-construct correlations.

**Source:** Authors' own illustration

**Table 4.** Assessment of high-order construct

| Higher-order construct | Lower-order construct | VIF | Weights | t-value | Convergent validity |
|---|---|---|---|---|---|
| Artificial autonomy (T1) | Action autonomy (AA) (T1) | 1.917 | 0.259 | 4.228** | 0.871 |
| | Sensing autonomy (SA) (T1) | 1.856 | 0.471 | 6.709** | |
| | Thought autonomy (TA) (T1) | 1.829 | 0.428 | 7.693** | |
| Trust (T2) | Trust: Cognitive trust (CT) (T2) | 1.976 | 0.387 | 7.547** | 0.850 |
| | Trust: Emotional trust (ET) (T2) | 1.976 | 0.690 | 15.094** | |

Notes: T1 = Time 1. T2 = Time 2. VIF = Variance inflation factor. ** = $p$ <0.01.

**Source:** Authors' own illustration

**Table 5.** Assessment of structural model

| Relationship | Std. β | Std. error | t-value | 95% & 97.5% BCa CI | | VIF |
|---|---|---|---|---|---|---|
| | | | | LB | UB | |
| *Direct effect* | | | | | | |
| H1a: Artificial autonomy (T1) → PSE (T2) | 0.657 | 0.025 | 26.010** | 0.611 | 0.694 | 1.000 |
| H1b: Artificial autonomy (T1) → Trust (T2) | 0.648 | 0.024 | 27.023** | 0.605 | 0.684 | 1.000 |
| H2a: PSE (T2) → SWB (T2) | 0.197 | 0.030 | 6.561** | 0.147 | 0.246 | 1.635 |
| H2b: PSE (T2) → CUI (T3) | 0.172 | 0.036 | 4.765** | 0.117 | 0.237 | 1.758 |
| H3a: Trust (T2) → SWB (T2) | 0.689 | 0.027 | 25.541** | 0.643 | 0.733 | 1.635 |
| H3b: Trust (T2) → CUI (T3) | 0.116 | 0.048 | 2.445** | 0.037 | 0.193 | 3.129 |
| H4: SWB (T2) → CUI (T3) | 0.599 | 0.053 | 11.280** | 0.513 | 0.687 | 3.151 |
| *Control variable* | | | | | | |
| Age → CUI (T3) | 0.093 | 0.146 | 0.633 | -0.163 | 0.408 | |
| Gender → CUI (T3) | 0.070 | 0.056 | 1.265 | -0.030 | 0.188 | |
| Education level → CUI (T3) | 0.028 | 0.034 | 0.815 | -0.025 | 0.098 | |
| Marital status → CUI (T3) | 0.024 | 0.083 | 0.290 | -0.113 | 0.160 | |
| Prior experience of using facial recognition technology → CUI (T3) | 0.062 | 0.053 | 1.167 | -0.033 | 0.096 | |
| *Sequential mediation effect* | | | | | | |
| H5: Artificial autonomy (T1) → PSE (T2) → SWB (T2) → CUI (T3) | 0.078 | 0.014 | 5.506** | 0.053 | 0.108 | |
| H6: Artificial autonomy (T1) → Trust (T2) → SWB (T2) → CUI (T3) | 0.267 | 0.026 | 10.113** | 0.216 | 0.322 | |

Notes: PSE = Perceived service enhancement. SWB = Subjective well-being. CUI = Continuance use intention. ** = $p < 0.01$. T1 = Time 1. T2 = Time 2. T3 = Time 3. BCa CI = Bias corrected accelerated confidence interval. 95% BCa CI is used for direct effect estimation and 97.5% BCa CI is used for sequential mediation estimation. LB = Lower bound. UB = Upper bound. VIF = Variance inflation factor. NA = Not applicable.

**Source:** Authors’ own illustration

**Table 6.** Assessment of predictive power

| Assessment | Item | PLS RMSE | LM RMSE | PLS-LM RMSE | Q²_predict | Decision of predictive power |
|---|---|---|---|---|---|---|
| PLSpredict | CUI1 | 1.188 | 1.192 | -0.004 | 0.326 | Strong |
| | CUI2 | 1.181 | 1.185 | -0.004 | 0.304 | |
| | CUI3 | 1.216 | 1.219 | -0.003 | 0.313 | |
| | CUI4 | 1.220 | 1.226 | -0.006 | 0.294 | |
| **Assessment** | **Focus on PSE, Trust, SWB, and CUI** | **PLS-SEM loss (M1)** | **Benchmark loss (M2)** | **Difference (M1-M2)** | **p-value** | **Decision of predictive power** |
| CVPAT | CVPAT benchmark indicator average (IA) construct | 0.595 | 1.006 | -0.411 | 0.000 | Strong |
| | CVPAT benchmark linear model (LM) construct | 0.595 | 0.602 | -0.007 | 0.001 | |

Notes: CUI = Continuance use intention. CVPAT = Cross-validated predictive ability test. PLS = Partial least square. PLS SEM = PLS structural equation modelling. RMSE = Root mean square error. $Q^2$ = Predictive relevance.

**Source:** Authors' own illustration

**Table 7.** Assessment of the moderated mediation

| Hypothesis | Conditional mediation effect | Std. β | Std. error | *t*-value | *p*-value | 95% BCa CI | |
|---|---|---|---|---|---|---|---|
| | | | | | | LB | UB |
| H7. Artificial autonomy→PSE→SWB→CUI | Index of moderated mediation | 0.013 | 0.004 | 2.861 | 0.002 | 0.006 | 0.021 |
| | Perceived technology security (Moderator) | | | | | | |
| | Low | 0.053 | 0.019 | 2.778 | 0.003 | 0.020 | 0.081 |
| | Medium | 0.058 | 0.021 | 2.703 | 0.003 | 0.025 | 0.092 |
| | High | 0.062 | 0.031 | 2.000 | 0.023 | 0.011 | 0.108 |
| H8. Artificial autonomy→TRS→SWB→CUI | Index of moderated mediation | 0.021 | 0.010 | 2.117 | 0.017 | 0.006 | 0.039 |
| | Perceived technology security (Moderator) | | | | | | |
| | Low | 0.145 | 0.036 | 4.017 | 0.000 | 0.017 | 0.280 |
| | Medium | 0.153 | 0.034 | 4.498 | 0.000 | 0.063 | 0.299 |
| | High | 0.161 | 0.035 | 4.608 | 0.000 | 0.130 | 0.323 |

Notes: AA = Artificial autonomy. PSE = Perceived service enhancement. TRS = Trust. SWB = Subjective well-being. CUI = Continuance use intention. BCa CI = Bias corrected accelerated confidence interval. LB = Lower bound. UB = Upper bound.

**Source:** Authors’ own illustration

Appendix

**Appendix A.** Measurement items

| | |
|---|---|
| **Action autonomy (AA)** | |
| AA1: Facial recognition payment can independently complete the operation of the payment. | |
| AA2: Facial recognition payment can independently implement the operation of the payment. | |
| AA3: Facial recognition payment can autonomously perform the operation of the payment. | |
| AA4: Facial recognition payment can carry out the operation of the payment autonomously. | |
| **Sensing autonomy (SA)** | |
| SA1: Facial recognition payment can autonomously be aware of me from the state of its surroundings. | |
| SA2: Facial recognition payment can autonomously recognise me from the environment. | |
| SA3: Facial recognition payment can independently recognise me from the environment. | |
| SA4: Facial recognition payment can independently monitor me from the environment. | |
| **Thought autonomy (TA)** | |
| TA1: Facial recognition payment can autonomously provide me choices of what to do without requiring human intervention | |
| TA2: Facial recognition payment can independently provide me recommendations for action plans for assigned matters without requiring human intervention. | |
| TA3: Facial recognition payment can independently recommend me an implementation plan of the assigned matters without requiring human intervention. | |
| TA4: Facial recognition payment can autonomously suggest to me on what can be done without requiring human intervention. | |
| **Perceived technology security (PTS)** | |
| PTS1: The risk of an unauthorized party intervening in the payment process is low. | |
| PTS2: The risk of abuse of user's information (e.g., payment amount, transaction history, purchasing patterns) is low when using a facial recognition payment. | |
| PTS3: The risk of abuse of payment information (e.g., bank account number and/or data) is low when using a facial recognition payment. | |
| PTS4: Overall, facial recognition payment is a safe platform in protecting sensitive information about myself. | |
| **Payment service enhancement (PSE)** | |
| PSE1: Facial recognition payment offers customers more options in paying. | |
| PSE2: Facial recognition payment enables the paying process to be easier and faster. | |
| PSE3: Facial recognition payment makes the paying process less hassle. | |
| PSE4: Facial recognition payment makes paying process more fun. | |
| PSE5: Facial recognition payment enhances customer service. | |
| **Trust: Cognitive trust (CT)** | |
| CT1: Facial recognition payment always provides me with an accurate financial service. | |
| CT2: Facial recognition payment always provides me with a reliable financial service. | |
| CT3: Facial recognition payment always provides me with a safe financial service. | |
| **Trust: Emotional trust (ET)** | |
| ET1: I feel secure using facial recognition payment for my payment. | |
| ET2: I feel comfortable using facial recognition payment for my payment. | |
| ET3: I feel content using facial recognition payment for my payment. | |
| Global item: Overall, I trust the use of facial recognition payment for my payment. | |
| **Subjective well-being (SWB)** | |
| SWB1: Using facial recognition payment is part of my ideal life. | |
| SWB2: The conditions of my life using facial recognition payment are excellent. | |
| SWB3: I am satisfied with my life when I am using facial recognition payment. | |
| SWB4: I am able to make transactions by using facial recognition payment. | |
| **Continuance use intention (CUI)** | |
| CUI1: I intend to continue using facial recognition payment. | |
| CUI2: I plan to keep using facial recognition payment. | |
| CUI3: I expect to continue using facial recognition payment. | |
| CUI4: If I could, I would like to continue my use of facial recognition payment. | |

**Source:** Authors' own illustration

**Appendix B.** Assessment of common method bias (CMB) using unmeasured latent method construct (ULMC)

| Construct | Path | Substantive loading | Substantive variance | t-value | Path | Method loading | Method variance | t-value |
|---|---|---|---|---|---|---|---|---|
| Action autonomy (AA) | AA → AA1 | 0.907 | 0.823 | 46.772** | Method → AA1 | -0.043 | 0.002 | 0.576 |
| | AA → AA2 | 0.903 | 0.815 | 46.830** | Method → AA2 | -0.046 | 0.002 | 1.191 |
| | AA → AA3 | 0.892 | 0.796 | 48.347** | Method → AA3 | 0.048 | 0.002 | 0.848 |
| | AA→ AA4 | 0.876 | 0.767 | 40.512** | Method → AA4 | 0.040 | 0.002 | 0.872 |
| Sensing autonomy (SA) | SA→ SA1 | 0.864 | 0.746 | 20.922** | Method → SA1 | -0.045 | 0.002 | 1.278 |
| | SA → SA2 | 0.900 | 0.810 | 36.053** | Method → SA2 | 0.050 | 0.003 | 0.970 |
| | SA → SA3 | 0.870 | 0.757 | 44.274** | Method → SA3 | 0.043 | 0.002 | 0.790 |
| | SA → SA4 | 0.822 | 0.676 | 40.885** | Method → SA4 | -0.040 | 0.002 | 0.247 |
| Thought autonomy (TA) | TA → TA1 | 0.786 | 0.618 | 32.397** | Method → TA1 | 0.167 | 0.028 | 3.335** |
| | TA → TA2 | 0.911 | 0.830 | 27.000** | Method → TA2 | -0.047 | 0.002 | 1.453 |
| | TA → TA3 | 0.877 | 0.769 | 46.025** | Method → TA3 | -0.047 | 0.002 | 0.236 |
| | TA → TA4 | 0.877 | 0.769 | 30.636** | Method → TA4 | -0.042 | 0.002 | 0.722 |
| Perceived technology security (PTS) | PTS → PTS1 | 0.903 | 0.815 | 49.059** | Method → PTS1 | 0.151 | 0.023 | 3.267** |
| | PTS → PTS2 | 0.913 | 0.834 | 42.803** | Method → PTS2 | 0.050 | 0.003 | 0.741 |
| | PTS → PTS3 | 0.919 | 0.845 | 47.290** | Method → PTS3 | -0.219 | 0.048 | 4.318 |
| | PTS → PTS4 | 0.879 | 0.773 | 33.954** | Method → PTS4 | 0.155 | 0.024 | 1.962* |
| Payment service enhancement (PSE) | PSE → PSE1 | 0.768 | 0.590 | 6.584** | Method → PSE1 | 0.048 | 0.002 | 0.408 |
| | PSE → PSE2 | 0.972 | 0.945 | 17.357** | Method → PSE2 | -0.168 | 0.028 | 5.396** |
| | PSE → PSE3 | 0.873 | 0.762 | 38.063** | Method → PSE3 | -0.043 | 0.002 | 1.511 |
| | PSE → PSE4 | 0.755 | 0.570 | 34.060** | Method → PSE4 | 0.171 | 0.029 | 3.439** |
| | PSE → PSE5 | 0.740 | 0.548 | 23.958** | Method → PSE5 | 0.148 | 0.022 | 3.289** |
| Trust: Cognitive trust (CT) | CT → CT1 | 0.892 | 0.796 | 35.730** | Method → CT1 | 0.038 | 0.001 | 0.320 |
| | CT → CT2 | 0.943 | 0.889 | 48.061** | Method → CT2 | -0.158 | 0.025 | 3.305** |
| | CT → CT3 | 0.859 | 0.738 | 34.628** | Method → CT3 | 0.037 | 0.001 | 1.377 |
| Trust: Emotional trust (ET) | ET → ET1 | 0.936 | 0.876 | 35.166** | Method → ET1 | -0.033 | 0.001 | 0.450 |
| | ET → ET2 | 0.910 | 0.828 | 32.425** | Method → ET2 | 0.029 | 0.001 | 0.267 |
| | ET → ET3 | 0.927 | 0.859 | 42.551** | Method → ET3 | 0.015 | 0.000 | 0.189 |
| Subjective well-being (SWB) | SWB → SWB1 | 0.948 | 0.899 | 20.667** | Method → SWB1 | 0.031 | 0.001 | 0.392 |
| | SWB → SWB2 | 0.899 | 0.808 | 29.089** | Method → SWB2 | -0.048 | 0.002 | 1.247 |
| | SWB → SWB3 | 0.902 | 0.814 | 30.709** | Method → SWB3 | -0.045 | 0.002 | 0.216 |
| | SWB → SWB4 | 0.878 | 0.771 | 32.655** | Method → SWB4 | 0.043 | 0.002 | 0.879 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Continuance use intention (CUI) | CUI → CUI1 | 0.915 | 0.837 | 36.123** | Method → CUI1 | 0.042 | 0.002 | 0.789 |
| | CUI → CUI2 | 0.957 | 0.916 | 38.285** | Method → CUI2 | -0.137 | 0.019 | 2.916** |
| | CUI → CUI3 | 0.938 | 0.880 | 38.130** | Method → CUI3 | -0.047 | 0.002 | 0.499 |
| | CUI → CUI4 | 0.864 | 0.746 | 21.191** | Method → CUI4 | 0.043 | 0.002 | 0.772 |
| Average | | | 0.786 | | | | 0.008 | |
| Ratio | | | | | | | 94.101 | |

Note(s): *$p < 0.05$; **$p < 0.01$

**Source:** Authors' own illustration

**Appendix C.** Cross-loadings

| Item | Action autonomy (T1) | Sensing autonomy (T1) | Thought autonomy (T1) | Perceived technology security (T1) | Perceived service enhancement (T2) | Trust: Cognitive trust (T2) | Trust: Emotional trust (T2) | Subjective well-being (T2) | Continuance use intention (T3) |
|---|---|---|---|---|---|---|---|---|---|
| AA1 | **0.897** | 0.565 | 0.544 | 0.386 | 0.500 | 0.439 | 0.398 | 0.456 | 0.456 |
| AA2 | **0.884** | 0.531 | 0.548 | 0.382 | 0.486 | 0.423 | 0.388 | 0.448 | 0.446 |
| AA3 | **0.906** | 0.571 | 0.559 | 0.418 | 0.510 | 0.454 | 0.430 | 0.479 | 0.478 |
| AA4 | **0.891** | 0.557 | 0.547 | 0.415 | 0.498 | 0.451 | 0.406 | 0.467 | 0.485 |
| SA1 | 0.537 | **0.870** | 0.522 | 0.459 | 0.478 | 0.461 | 0.464 | 0.491 | 0.499 |
| SA2 | 0.542 | **0.879** | 0.513 | 0.426 | 0.515 | 0.494 | 0.459 | 0.459 | 0.450 |
| SA3 | 0.544 | **0.868** | 0.495 | 0.420 | 0.518 | 0.460 | 0.455 | 0.493 | 0.484 |
| SA4 | 0.527 | **0.840** | 0.537 | 0.451 | 0.471 | 0.486 | 0.471 | 0.481 | 0.448 |
| TA1 | 0.538 | 0.546 | **0.840** | 0.427 | 0.483 | 0.539 | 0.437 | 0.516 | 0.449 |
| TA2 | 0.524 | 0.515 | **0.883** | 0.421 | 0.500 | 0.501 | 0.426 | 0.484 | 0.450 |
| TA3 | 0.519 | 0.523 | **0.871** | 0.441 | 0.490 | 0.495 | 0.438 | 0.495 | 0.457 |
| TA4 | 0.541 | 0.478 | **0.859** | 0.427 | 0.487 | 0.491 | 0.415 | 0.480 | 0.438 |
| PTS1 | 0.419 | 0.491 | 0.472 | **0.938** | 0.506 | 0.646 | 0.805 | 0.776 | 0.695 |
| PTS2 | 0.426 | 0.457 | 0.471 | **0.930** | 0.517 | 0.618 | 0.771 | 0.760 | 0.693 |
| PTS3 | 0.386 | 0.441 | 0.440 | **0.916** | 0.440 | 0.590 | 0.736 | 0.723 | 0.632 |
| PTS4 | 0.427 | 0.494 | 0.461 | **0.926** | 0.520 | 0.638 | 0.772 | 0.775 | 0.697 |
| PSE1 | 0.448 | 0.430 | 0.488 | 0.419 | **0.780** | 0.488 | 0.482 | 0.474 | 0.462 |
| PSE2 | 0.427 | 0.421 | 0.426 | 0.365 | **0.831** | 0.410 | 0.431 | 0.458 | 0.474 |
| PSE3 | 0.459 | 0.516 | 0.438 | 0.415 | **0.836** | 0.454 | 0.478 | 0.507 | 0.521 |
| PSE4 | 0.461 | 0.484 | 0.455 | 0.474 | **0.816** | 0.475 | 0.479 | 0.550 | 0.515 |
| PSE5 | 0.488 | 0.495 | 0.517 | 0.509 | **0.841** | 0.538 | 0.502 | 0.571 | 0.566 |
| CT1 | 0.470 | 0.504 | 0.561 | 0.582 | 0.525 | **0.898** | 0.596 | 0.610 | 0.511 |
| CT2 | 0.459 | 0.498 | 0.528 | 0.564 | 0.532 | **0.904** | 0.604 | 0.601 | 0.501 |
| CT3 | 0.404 | 0.479 | 0.494 | 0.661 | 0.502 | **0.892** | 0.691 | 0.642 | 0.530 |
| ET1 | 0.426 | 0.509 | 0.459 | 0.792 | 0.499 | 0.672 | **0.925** | 0.717 | 0.638 |
| ET2 | 0.398 | 0.488 | 0.451 | 0.737 | 0.563 | 0.630 | **0.917** | 0.737 | 0.677 |
| ET3 | 0.434 | 0.484 | 0.467 | 0.777 | 0.545 | 0.647 | **0.930** | 0.739 | 0.648 |
| SWB1 | 0.442 | 0.510 | 0.501 | 0.730 | 0.562 | 0.605 | 0.710 | **0.907** | 0.741 |
| SWB2 | 0.499 | 0.517 | 0.564 | 0.767 | 0.582 | 0.636 | 0.730 | **0.926** | 0.735 |
| SWB3 | 0.468 | 0.521 | 0.552 | 0.767 | 0.592 | 0.646 | 0.741 | **0.923** | 0.722 |
| SWB4 | 0.467 | 0.469 | 0.454 | 0.702 | 0.536 | 0.609 | 0.686 | **0.869** | 0.706 |
| CUI1 | 0.488 | 0.512 | 0.498 | 0.716 | 0.572 | 0.550 | 0.674 | 0.754 | **0.934** |
| CUI2 | 0.490 | 0.505 | 0.457 | 0.673 | 0.588 | 0.507 | 0.648 | 0.707 | **0.925** |
| CUI3 | 0.476 | 0.499 | 0.479 | 0.662 | 0.569 | 0.532 | 0.652 | 0.728 | **0.923** |
| CUI4 | 0.462 | 0.483 | 0.475 | 0.641 | 0.552 | 0.516 | 0.626 | 0.754 | **0.892** |

Note(s): Appendix C presents a discriminant analysis method through cross-loading comparison between constructs. The results indicate that the loadings of indicators on their assigned latent variable (bold values) exceed those on other latent variables by more than 0.1 (Chin, 1998). This confirms that our constructs achieve discriminant validity and are clearly distinct from one another.
**Source:** Authors' own illustration