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Net valence analysis of iris recognition technology-based FinTech

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Abstract

Iris recognition technology (IRT)-based authentication is a biometric financial technology (FinTech) application used to automate user recognition and verification. In addition to being a controversial technology with various facilitators and inhibitors, the adoption of IRT-based FinTech is driven by contextual factors, such as customer perceptions, deployed biometric technology, and financial transaction settings. Due to its controversial and contextual properties, analyzing IRT-based FinTech acceptance is challenging. This study uses a net valence framework to investigate the salient positive and negative factors influencing the intention to use IRT-based FinTech in automated teller machines (ATMs) in Jordan. This study is pertinent because there is a dearth of research on IRT-based FinTech in the relevant literature; most previous research has taken purely engineering and technical approaches. Furthermore, despite considerable investments by banks and other financial institutions in this FinTech, target user adoption is minimal, and only 6% of Jordan's ATM transactions are currently IRT-enabled. This study employs mixed methods. In the first qualitative study, 17 Jordanian customers were interviewed regarding the benefits and risks of IRT-based FinTech in ATMs. Content analyses determined the most important concepts or themes. The advantages include financial security, convenience, and FinTech-enabled hygiene, whereas the concerns include performance, financial, privacy, and physical risks. The research model is constructed based on the qualitative study and theoretical underpinnings, wherein 631 Jordanian bank customers with active ATM accounts were surveyed to validate the research model. The findings indicate that IRT-based FinTech usage in ATMs is proportional to its perceived value. In descending order of effect, financial security, FinTech-enabled hygiene, and convenience benefits positively impact perceived value. Privacy, financial, and physical risks have negative impacts on perceived value, whereas performance risk has no effect. This study contributes to the relatively untapped domain of biometric technology in information systems, with important theoretical and practical implications.

Keywords: Iris recognition technology (IRT), FinTech, Biometric technology, Net valence, Perceived value, Adoption intention, Jordan

Introduction

The financial sector has been undergoing a significant transformation as a result of contemporary advances in information and communications technology. The technologies of the fourth industrial revolution have profoundly affected the business models of

banks and other financial institutions, thereby leading to the emergence of new markets and competitors in the financial industry. Financial technology (FinTech) is a trend that emerged due to the greater visibility of the application of cutting-edge technologies in the banking and financial sectors. FinTech can be described as the use of disruptive technologies, such as artificial intelligence, machine learning, cloud computing, the Internet of Things, contactless payments, blockchain, big data, digital currencies, and biometric identification, that have the potential to revolutionize the delivery of financial services; stimulate the creation of novel business models, products, and services;, and enable the financial services industry to become more customer-centric (Chen et al. 2021; Murinde et al. 2022).

Biometric FinTech refers to the use of physiological and behavioral features to automate individual recognition and verification (Byun and Byun 2013). According to Down and Sands (2004), faces, fingerprints, irises, retinas, and hands are regularly measured physical attributes. Physiological characteristics are inherited characteristics that manifest throughout the early stages of human development; however, the authors contended that an individual's voice, handwriting, and keystroke dynamics are also observable behavioral traits that can be analyzed, thereby demonstrating that such traits are not innate but acquired. Recently, the use of biometric technologies in the financial industry has tremendously increased. One example of FinTech biometric applications founded on individuals' physiological characteristics is iris recognition technology (IRT)-based authentication mechanisms. IRT is based on an ocular scan technology of the colored area of the eye in front of the lens that is used to identify and verify a person's identity at an automated teller machine (ATM), a teller desk, or a contactless payment system.

In 2008, IRT-based FinTech was fully integrated into the banking system of one bank operating in Jordan, thereby establishing the world's first fully operational banking solution based on IRT (Al-Debei and Aloudat 2013; Paragi and Altamimi 2022). Since then, many Jordanian and international institutions have deployed or are considering the integration of IRT into banking services. By means of this cutting-edge technology, banks and other financial organizations can effectively and efficiently regulate access by authenticating customers based on their distinct physiological biometric characteristics.

IRT-based FinTech is generally considered *controversial* information technology (IT), which is defined by Breward et al. (2017: p. 1) as "a technology that is generally perceived as having the potential to both benefit and undermine the well-being of the user." Controversial technology is typically affected by enablers and inhibitors. In contrast to enablers, which are positive factors increasing user acceptance of technology, inhibitors are factors that discourage technology adoption (Talukder et al. 2021; Tsai et al. 2019).

From a customer perspective, IRT-based FinTech offers notable advantages in terms of security because it aids the prevention of fraud cases, such as impersonation. Eliminating the requirement to use bank account cards and personal identification numbers (PINs) can also greatly contribute to the improvement of customers' experience. This approach is also hygienic because it prevents the spread of contagious diseases due to its contactless nature.

Although IRT-based FinTech could have beneficial effects, its adoption rate among target customers is limited and considerably below what is anticipated (Byun and Byun 2013; Breward et al. 2017; Liébana-Cabanillas et al. 2022). The low adoption

rate of IRT can be attributed to its controversial nature, as it provides customers with benefits but also raises multiple concerns and has risks related to performance, privacy, finances, and health. Customers may be concerned that IRT will not operate as expected or will not provide the desired benefits. In addition, customers may be concerned about the potential loss of control over personal information, such as personal data being used without their knowledge or consent, or the risk of losing money due to fraud or a false iris recognition match. IRT may also raise health concerns for customers, who may wonder whether the imager is harmful to the eye, employs a laser beam, or affects pregnant women. Therefore, customers conduct risk–benefit analyses known as net valence, whereby perceived value is determined. If the net valence is positive, the adoption of IRT-based FinTech will be promoted, whereas a negative score suggests a reluctance to use the technology.

In addition to its controversial characteristics, biometric-based FinTech is *contextual*, which suggests that customer perceptions of biometric-based FinTech vary across social and cultural contexts of use, the biometric technologies employed, and the functional contexts of financial transactions (Byun and Byun 2013; Hossain and Dwivedi 2014; Breward et al. 2017; Liébana-Cabanillas et al. 2022). Acknowledging the contextual characteristics of IRT-based FinTech, this study identifies the main benefits and risks customers associate with the use of IRT-based FinTech as biometric technology for ATM-based banking transactions in the particular functional context of use and from the perspective of Jordanian customers as a specific social and cultural context. Accordingly, in this study, Jordan is the social and cultural context of use, IRT-based FinTech is the biometric technology examined, and ATMs are the contextual channels for banking transactions.

The first objective of this study is to explore the salient benefits and risks of IRT-based FinTech for ATM-based banking transactions from the perspective of Jordanian consumers through qualitative research. Because biometric-based FinTech is also controversial, the second objective is to develop a contextualized research model based on a net valence framework (NVF) and qualitative research findings to understand the barriers to and facilitators of customer adoption of IRT-based FinTech. The study's third objective is to empirically validate the developed model to draw evidence-based conclusions and relevant implications for theory and practice. Accordingly, this study will address the following research questions:

RQ1 What are the salient benefits and risks of IRT-based FinTech for ATM banking transactions from the perspective of Jordanian customers?

RQ2 Are customers' perceptions of the value of IRT-based FinTech for ATM banking transactions influenced by the salient benefits and risks?

RQ3 What impact does perceived value have on the intention to use IRT-based FinTech for ATM banking transactions?

These research questions are vital because the solutions identified will contribute novel insights to the existing body of literature. The contributions of this study can

be summarized as follows. First, our research focuses on a specific kind of technology (biometric-based FinTech in general and IRT-based FinTech in particular) that has been relatively unexplored in existing literature (Breward et al. 2017). It is essential to address the research questions presented due to the paucity of studies on IRT-based FinTech in information systems (IS) literature; the majority of existing studies approach this topic from strictly engineering and technical perspectives. Despite its significance, very few empirical studies have examined consumers' acceptance and use of biometric technologies, particularly IRT, in banking (Liébana-Cabanillas et al. 2022; Kajol et al. 2022). Consequently, the key motivating factors and challenges related to adopting and using biometric-based FinTech, specifically IRT, are not fully understood.

Second, this study adopts the NVF as its main theoretical foundation. It is crucial to develop study models based on theoretical frameworks that can be used to analyze controversial technologies to generate practical insights. This is significant because the use of traditional theories and models that were not designed to examine controversial technologies, such as the technology acceptance model (TAM) (Davis 1989), theory of planned behavior (Ajzen 1991), diffusion of innovation theory (Rogers 1995), and unified theory of acceptance and use of technology (Venkatesh et al. 2003), may be inappropriate without adequate contextualization and modifications.

These technology adoption theories often overlook inhibitors (Tsai et al. 2019; Breward et al. 2017). However, individuals weigh positive and negative effects before accepting new technologies (Bhattacherjee and Hikmet 2007) such as IRT-based FinTech. Safety concerns make users hesitant. Therefore, a theoretical analysis of factors affecting user acceptance of IRT-based FinTech is crucial. Third, this study explores and validates the adoption of IRT-based FinTech in a social and cultural context that has received relatively little attention (i.e., the Arab world) compared with Western nations, which most previous research has focused on. Because the cultural, social, and economic characteristics of the Arab region radically differ from those of developed nations, bridging this gap is crucial (Albanna et al. 2022). Thus, there is a pressing need to understand the factors that motivate and discourage individuals in this cultural and social context from adopting IRT-based FinTech to target and reinforce usage drivers more effectively while also identifying and addressing potential concerns and making strategic progress to overcome them. Understanding and analyzing customer decision-making regarding technology acceptance is challenging (Dillon 2001; Al-Debei and Al-Lozi 2014; Breward et al. 2017), and this difficulty is compounded when the examined technology is controversial and deployed in a developing nation, as in this study.

Despite the significant investments in FinTech, including IRT-based authentication, adoption among users remains lower than expected (Breward et al. 2017; Liébana-Cabanillas et al. 2022). In Jordan, IRT-enabled ATM transactions only make up 6% of all transactions (Central Bank of Jordan 2021). Understanding the facilitators and inhibitors of IRT-based FinTech will be beneficial for banks and financial institutions in Jordan and the Arab world. This study uses a mixed methods approach (qualitative study to determine indicators, followed by quantitative validation) to develop a research model for Jordan's social and cultural context. It introduces a new theoretical concept called "FinTech-enabled hygiene benefit" and validates the model through a quantitative study.

Few studies have used this approach to consider the contextual aspects of biometric-based FinTech.

The rest of the paper is structured as follows. Relevant literature, the theoretical framework, and the research context are discussed in the next section. Then, the qualitative examination of the principal benefits and risks of using IRT-based FinTech is elaborated upon. The subsequent section introduces and discusses the study model and hypotheses development. The second (quantitative) study then validates the research model and yields important results. After a comprehensive analysis of the results, the theoretical and practical implications are proposed. The study concludes with its primary findings and recommendations for future research.

Theoretical background and literature review

The underlying theory: net valence framework

The NVF, which has also been referred to as the cognitive–rational consumer decision-making paradigm, is the primary underlying theory for this study. Peter and Tarpey (1975) proposed this paradigm, asserting that consumers act intellectually and rationally. According to this approach, consumers are goal-oriented, analytical, and aware of the pros and cons of the available options when making a choice. This model is associated with three separate decision-making techniques. First, a risk perception technique is engaged wherein consumers strive to reduce any undesirable costs or sacrifices. Second, a perceived return technique occurs wherein consumers attempt to maximize advantages. Finally, a net valence strategy is undertaken wherein customers maximize net return or net valence by evaluating the difference between expected positive and negative consequences.

The NVF is congruent with other theories and frameworks, such as privacy calculus (see Liu et al. 2021; Sandhu et al. 2023) and value-based approaches (see Kim et al. 2007; Al-Debei et al. 2013; Byun and Byun 2013), which attempt to comprehend consumers' adoption of innovative and controversial technologies from a "perceived value" perspective. The rationale is that customers evaluate the value of a product or service based on what is "received" and what is "provided" before deciding whether to use a certain technology (Zeithaml 1988). Therefore, these perspectives agree that consumers' decision to embrace technology is based on a cognitive process that examines the disparity between the offered benefits and imposed risks. This philosophical reasoning is sensible in the context of this investigation because IRT in the banking industry is considered controversial technology that offers customers benefits but also raises some concerns. In addition, the setting in which IRT is used involves monetary transactions; hence, it is reasonable to assume that people will respond more rationally and less emotionally or subjectively when considering transactions with financial implications.

Thus, we argue that researchers should adopt the NVF, which examines the positive and negative characteristics that consumers consider when adopting controversial technology (Cazier et al. 2008). This study contends that customers will always consider the value (gains vs. concerns) of a product or service before committing to its use, particularly when it involves the use of controversial technology with financial implications, such as IRT-based FinTech. Despite the significance of examining the driving forces of technology adoption, the more controversial a technology is, the greater the importance

that strategically addressing the underlying risks and concerns will be, as user acceptance will continue to lag behind progress if the elements that encourage or inhibit user adoption of these technologies are not identified (Breward et al. 2017).

Previous research

There is a dearth of research in the IS field that has examined motivators and inhibitors using the NVF or other well-established theories and models. One exception is James et al. (2006), who conducted one of the earliest studies to assess consumer acceptance of biometric devices used in various scenarios in the United States (US). The research used an expanded version of the TAM. The research revealed that the perceived need for security and perceived ease of use positively influenced consumers' perceptions of a biometric device's usefulness. In contrast, the perceived physical invasiveness of biometric devices was found to negatively affect individuals' intentions to use these devices. According to the results, perceived usefulness and perceived ease of use significantly influenced consumers' intentions to use biometric applications.

In the banking industry, Byun and Byun (2013) examined different dimensions of benefits and risks associated with the use of biometric technology (i.e., fingerprints at ATMs) from the perspective of existing and potential customers, with a focus on perceived consumer value. Examining data acquired from customers of a US bank, the study determined that enjoyment was the most prominent advantage reported by existing and potential consumer groups when using this technology. In addition, security advantages when conducting financial transactions and the novelty of biometric technology were found to be among the primary motivators for the technology's adoption. The results suggested that US fingerprint system users were mostly concerned about information privacy. In addition, a substantial correlation was discovered between perceived consumer value, which increases when customers perceive more benefits and fewer concerns, and the behavioral intention of existing and potential customers to use fingerprints at ATMs.

Similarly, Breward et al. (2017) developed and empirically validated a contextualized theoretical framework based on net valence theories that include the positive and negative aspects of technology adoption to examine consumer acceptance of biometric technology (i.e., fingerprints) for banking transactions conducted through ATMs in the US. In this study, fingerprint biometric technology was considered controversial technology to which customers responded rationally when opting to use it by weighing the perceived benefits and risks of accessible alternatives. The study revealed that US consumers' attitudes toward using fingerprint biometric identification at ATMs are shaped by the simultaneous evolution of perceived benefits and concerns regarding emerging controversial technology. Although the study indicated convenience and greater account security as the primary antecedents of attitudes regarding the perceived benefits of biometric technology at ATMs, security and privacy were recognized as the primary perceived concerns. The study also demonstrated that trust in and familiarity with a bank positively affect perceived benefits in terms of convenience and account security. In addition, trust in the bank and perceived control were found to alleviate security and privacy concerns.

Previous research has explored the influence of various determinants on consumers' acceptance of biometric-enabled digital payment services (Lee and Pan 2022; Liébana-Cabanilla et al. 2022; Liu et al. 2021; Moriuchi 2020; Palash et al. 2022; Wang 2021). Lee and Pan (2022) applied the stressor–strain–outcome framework to investigate users' resistance to facial recognition mobile payments in China. The findings showed that stressors (i.e., information overload, system failure overload, perceived risk, privacy concerns, and technological uncertainty) exaggerate the strain (i.e., technostress), which then drives consumers' reluctance to adopt facial recognition mobile payments and increases negative word of mouth about it.

Similarly, Liu et al. (2021) investigated how factors of privacy perceptions impact individuals' resistance to using facial recognition mobile payments in China. The study's results demonstrated that perceived benefits negatively influence consumers' resistance, whereas privacy concerns positively impact consumers' reluctance to adopt facial recognition mobile payments. In addition, perceived privacy risk was found to significantly affect users' resistance to such technology. Furthermore, the findings confirmed that perceived privacy risk and privacy control have significant relationships with privacy concerns.

Liébana-Cabanilla et al. (2022) employed the stimulus–organism–response framework to explore the major antecedents of intention to use and recommend biometric mobile payments using IRT in Spain during the COVID-19 pandemic. Personal innovativeness, habit, comfort to use, and perceived trust were identified as the main antecedents of intention to use and recommend biometric mobile payments. Moriuchi (2020) examined factors affecting users' willingness to adopt facial recognition payment services in the US. Grounded in the unified theory of acceptance and use of technology and the theory of mind, the research demonstrated the significant roles of performance expectancy, social influence, and perceived risk in predicting a user's intention to use a facial recognition payment system. Furthermore, the study established that the impacts of antecedents on customers' usage intentions and the moderating/mediating roles of attitude, trust, and self-efficacy are dependent on shopping modality (i.e., online vs. in-store shopping). In the case of an online business, perceived risk was a substantial predictor of the intent to use the face recognition payment system, whereas in the case of a brick-and-mortar store, perceived risk was insignificant.

Palash et al. (2022) used the NVF to analyze the determinants of users' behavioral intention to use facial recognition payment systems among Chinese consumers and showed that privacy risk and relative advantage are the two foremost predictors of users' intention to use such systems. The relative advantage, in their study, represents the security and convenience benefits that customers can enjoy by using biometric technologies. Wang (2021) extended the TAM by including two new factors—perceived trust and perceived privacy—to examine users' acceptance of biometric recognition methods in FinTech applications. Interestingly, the study revealed that users' perceptions regarding the studied predictors differed based on the type of biometric identification. For instance, facial recognition was found to evoke minor user privacy concerns compared with other biometric identification methods (iris, voice, and fingerprint recognition). Table 1 provides a summary of the relevant studies.

Table 1 Brief summary of previous relevant studies

Source	Cultural context	Biometric technology in use	Use case	Benefits/gains	Risks/concerns	Methodology/ approach	Underpinning theory
James et al. (2006)	USA	Various biometric technologies (retinal scanners, fingerprint scanners, hand geometry scanners, signature biometrics, and facial recognition devices)	Different use cases (physical access, virtual access, e-commerce, and covert surveillance)	Perceived need for security Perceived need for privacy	Perceived physical invasiveness	Quantitative research design using a survey instrument	Extended TAM model
Byun and Byun (2013)	USA	Fingerprints	Financial Transactions via ATMs	Increased security Cognitive effort saving Time convenience Perceived enjoyment	Performance risk Information privacy risk Physical risk	Quantitative research design using a survey instrument	Value-based adoption/ Net Valence Framework (NVF)
Breward et al. (2017)	USA	Fingerprints	Financial Transactions via ATMs	Account security Convenience	Privacy concerns Security concerns	Mixed Methodology (qualitative and quantitative)	Cognitive-rational consumer decision-making paradigm/ Net Valence Framework (NVF)
Moriuchi (2020)	USA	Facial recognition	Payment method either through laptop cameras or smartphone cameras	Performance expectancy Effort expectancy	Risk	Two quantitative studies—study 1: general validation of the model; study 2: Validate the model using two distinct modes of customer shopping (online versus in-person)	UTAUT and ToM
Wang (2021)	N/A	Face recognition, fingerprint recognition, iris recognition, and voice recognition	Biometric identification in FinTech Applications	Perceived ease of use Perceived usefulness Perceived trust Perceived privacy	N/A	Analytic Hierarchy Process (AHP)	Extended TAM model
Liu et al. (2021)	China	Facial recognition	Mobile payment services	Perceived benefits	Perceived privacy risk	Quantitative research design using a survey instrument	Privacy calculus

Table 1 (continued)

Source	Cultural context	Biometric technology in use	Use case	Benefits/gains	Risks/concerns	Methodology/ approach	Underpinning theory
Liébana Cabanilla et al. (2022)	Spain	Iris recognition technology	Payment method utilizing mobile phones	Convenience Effort expectancy	N/A	Quantitative research design using a survey instrument	Stimulus- Organism- Response (S–O-R) framework
Palash et al. (2022)	China	Facial recognition	Payment method via smartphones or point of sale terminals	Relative advantage Initial trustPerceived playfulness Need for uniqueness	Perceived risk Technophobia Perceived complexity	Quantitative research design using a survey instrument	Net Valence Framework (NVF)
Lee and Pan (2022)	China	Facial recognition	Mobile payment services	N/A	System feature overload Information overload Technological uncertainty Perceived risk Privacy concern	Quantitative research design using a survey instrument	Stressor–Strain–Outcome (S–S–O) framework

Thus, a critical review of the relevant literature reveals that scholarly research has primarily focused on the organizational and technical aspects of biometric system development and the adoption of controversial IT is understudied (Breward et al. 2017). Few studies have examined consumers' usage patterns of controversial IT, particularly IRT, in a banking context. However, without identifying the factors that facilitate or impede user adoption of such technologies, user acceptance will continue to lag behind the rate of technological advancement.

In addition, prior research has argued that consumers' perceptions regarding the benefits and risks of biometric technology may differ based on the specific type of biometric technology used (Liébana-Cabanillas et al. 2022; Byun and Byun 2013; Alterman 2003). For instance, consumers have negative perceptions regarding IRT compared with fingerprint systems due to health-related concerns (i.e., effect on vision), although IRT is evaluated as the most secure biometric technology for user authentication (Liébana-Cabanillas et al. 2022; Byun and Byun 2013; Furnell and Evangelatos 2007). Our examination of the relevant literature also revealed that few studies have investigated the adoption of biometric systems in the financial sector focusing on IRT. This additional detail strengthens the contribution of the current study.

Moreover, existing research has largely focused on Western countries. Consequently, minimal studies have explored biometric systems adoption and use in developing nations in general and Arab countries in particular. This gap is significant given that the cultural, social, and economic characteristics of the Arab region radically differ from those of developed nations (Albanna et al. 2022; Al-Hujran et al. 2015). Consumers' acceptance of biometric systems may differ with the cultural context of its use (Byun and Byun 2013). For example, Riley et al. (2009) conducted a cross-cultural study to investigate users' attitudes toward biometric technology and found that respondents from India positively evaluated biometric technology in terms of security, ease of use, and speed compared with their counterparts in the United Kingdom and South Africa.

In addition, our analysis of relevant literature revealed that prior research on this topic has emphasized the controversial nature of biometric technologies but ignored their contextual characteristics, despite their importance. This is evident when examining the research methodologies employed in each study. From the identified relevant literature, only one study (Breward et al. 2017) examining fingerprint adoption in ATMs used mixed methods wherein the findings of a qualitative study were used to develop the research model, as in our study.

This study aims to bridge the identified gaps in the literature by determining what influences customers' behavioral intentions to use biometric technologies by considering their perceived benefits and concerns from a net valence perspective. This study focuses specifically on Jordanian consumers' intention to use IRT-based FinTech as controversial and contextual technology for ATM-based financial transactions.

FinTech and banking in Jordan

FinTech is related to the application of technical innovations to yield and assess finance (Elia et al. 2022; Alkhazaleh and Haddad 2021). The Jordanian banking sector is one of the kingdom's most important economic sectors, and the number of FinTech applications is continuously expanding. Jordan's banking industry has developed over the past

two decades, which is attributed to the government's unwavering dedication to constructing and maintaining a cutting-edge IT infrastructure for the banking sector and the country's strategic location, political and economic stability despite its unpredictable surroundings, and highly developed IT industry (AL-Khatib 2022; Abu-Shanab et al. 2010).

Jordan's banking industry was significantly affected by the digital transformation (AL-Khatib 2022). Moving toward the fourth industrial revolution, Jordanian commercial banks have implemented FinTech applications such as internet banking (Alalwan et al. 2018), mobile banking (Alalwan et al. 2016a), big data analytics (AL-Khatib 2022), telebanking (Alalwan et al. 2016b), self-service technology (Baabdullah et al. 2019), near-field communication (NFC) technology (Matar and Alkhawaldeh 2022), and biometric technologies (Lemberg-Pedersen and Haioty 2020). These reforms have facilitated the growth of banking operations and services to the extent that multinational banks have expressed interest in establishing local branches, which has increased competitiveness in the Jordanian banking industry. Presently, there are a range of domestic, international, and Islamic banks among Jordan's 26 banks and financial organizations. As of the end of 2021, these banks had over 878 facilities in Jordan and 2195 ATMs, although the latter were typically less prevalent in remote locations (Central Bank of Jordan 2021).

The Central Bank of Jordan continuously advocates providing an appropriate legislative environment for developing and adopting technological innovations to deliver enhanced banking services. To contribute to achieving and strengthening financial inclusion, the Central Bank also acts as a supporter and catalyst for banks to develop electronic payment channels and promote their use. Therefore, the payment cards issued by banks operating in the kingdom and electronic payment transfer companies licensed by the Central Bank in 2021 recorded 4,345,849 payments from credit, debit, and prepaid cards, which was 7% more than the previous year.

As a result of the COVID-19 pandemic, the need for electronic payments and FinTech has become urgent (Matar and Alkhawaldeh 2022). In Jordan, the use of electronic payments has hastened in the last two years. Statistics from the Central Bank of Jordan indicate a notable increase in the use of electronic payment channels offered by banks; the total transactions conducted through electronic means, including ATMs, the internet, and smartphones, accounted for 67% of all payment transactions conducted in the past year compared with 33% conducted through traditional bank channels (i.e., counters). In 2021, the total amount of electronic payments made using the internet and mobile banking reached 36.5 billion Jordanian dinars (1 Jordanian Dinar = 1.4 USD), and the number of mobile payment transactions reached 25 million in 2021, with a total value of 2 billion dinars (Central Bank of Jordan 2021).

There is also an increased interest in biometric technologies in the Jordanian banking industry. According to a report published by the Central Bank of Jordan (2021), 101 ATM machines across the country were already equipped to use biometric verification. In 2008, a Jordanian bank became the first in the world to integrate IRT technology into its ATMs (Paragi and Altamimi 2022). Two years later, another bank became the second in Jordan to use this technology. In addition, in 2021, another bank was the first in the region to launch a contactless biometric Mastercard that allows customers to authenticate transactions using their fingerprints. A fourth bank launched a new digital

biometric service called "Finger Vein Recognition Service and Digital Voucher Solution" in 2022. Subsequently, customers of this bank are no longer required to present identification documents when conducting counter transactions because their finger veins serve as identification.

Jordanian banks have used biometric systems to facilitate banking services for local clients and to assist and support refugees in Jordan. Jordan is home to over 750,000 Syrian refugees who receive assistance from United Nations (UN) agencies and other humanitarian organizations (Holloway et al. 2021). The UN High Commissioner for Refugees (UNHCR), a bank in Jordan, and a biometric FinTech company have collaborated to launch a biometric registration system that allows refugees to receive cash assistance through IRT-enabled ATMs available in every governorate in Jordan (Gilert and Austin 2017; Lemberg-Pedersen and Haioty 2020; UNHCR 2017). The UNHCR distributed close to 5.5 million USD per month to approximately 32,500 Syrian refugee families living in Jordan through an ATM network equipped with IRT (Hall 2019). The adoption of IRT by the UNHCR in Jordan ensures that cash assistance reaches the intended people, thereby significantly minimizing the possibilities for fraud (UNHCR 2017).

Nevertheless, although IRT scanning has been used in Jordan for the past decade, most banks' customers still hesitate to adopt this technology. Official statistics published by the Central Bank of Jordan in 2021 showed that the IRT-enabled transactions performed through ATM machines represent only around 6% of total transactions (Central Bank of Jordan 2021). This may indicate that customers weigh the benefits and risks of IRT-based FinTech before deciding whether to adopt it. Hence, promoting the technology's primary advantages and benefits may be inadequate for significantly boosting its adoption rate; rather, the challenge lies in identifying and analyzing the primary customer concerns and perceived risks and developing strategies and techniques for mitigating or eliminating them.

Research design

Study one: qualitative exploratory study

Study methods and approach

This research follows a general method to develop a mixed-method research design (Venkatesh et al. 2013). Consequently, the first study employs a qualitative research design by conducting semi-structured interviews. The interviews aim to explore the most important benefits and risks that can significantly impact consumers' intention to adopt IRT-based FinTech in ATMs. According to Yin (2009), collecting information by conducting interviews (e.g., semi-structured) offers certain advantages, such as allowing researchers to concentrate on the areas of interest and effectively explaining the causal inferences.

Our study used a purposive sampling technique to select participants. This technique meets the study objective is a standard method used in qualitative studies to identify and select the most resourceful cases and effectively allocate limited resources (Patton 2002). Furthermore, maximum variation was sought in the respondents by including different genders and a wide range of ages, educational backgrounds, and professional specializations. According to Patton (2015), acquiring as much variety as

possible is necessary to identify any common patterns in underlying experiences and shared characteristics of a phenomenon arising from considerable variation.

We conducted 17 interviews (n = 17) with banking customers who actively used banking services, especially ATM services. We followed the recommendations of Guest et al. (2006) to determine when the data would be deemed "saturated." As a result, we reached data saturation after 13 interviews. The information collected from the remaining interviews (i.e., the fourteenth through the seventeenth), which did not provide any new insights, did not significantly contribute to the conclusions that had already been drawn.

In this study, an active banking customer of ATMs is defined as a customer who visits ATMs at least once a week. Most participants were employed individuals (n = 12; 71%), whereas the rest were students (n = 5; 29%), including two graduates and three undergraduates. The average age of the participants was around 34 years, and most were males (n = 10; 59%), while the rest were females (n = 7; 41%). The participants were customers of four different banks in Jordan. We conducted face-to-face interviews in an informal setting. The interviews lasted for 25 min on average. In the interviews, the participants were asked to answer the following three main open-ended questions:

1. *What are the benefits of using IRT-based FinTech in ATMs?*
2. *What are the risks associated with the use of IRT-based FinTech in ATMs?*
3. *Do you have any suggestions and comments about the use of IRT-based FinTech in ATMs?*

Given that it is crucial to establish a firm understanding of the benefits and drawbacks of IRT-based FinTech as a controversial technological innovation and the scattered, confusing, contextual, and insufficient nature of our current understanding of these factors, it is essential to delve into customers' perspectives and analyze them to present a coherent framework to make the findings explicit. All recorded information from the interviews was transcribed. Then, we applied thematic analysis, a robust and flexible data analysis technique that provides a comprehensive and nuanced view of the data (Braun and Clarke 2006). Because the data were textual and narrative and sourced from customers' thoughts on the advantages and disadvantages of IRT-based FinTech in the digital business landscape, thematic analysis was deemed appropriate (Braun and Clarke 2006; Al-Debei and Avison 2010). The objective was to comprehend the phenomenon under examination by analyzing the meanings that individuals associate with it. When examining qualitative information, new insights, concepts, and themes may emerge (Roberts et al. 2019).

Thematic analysis is primarily described as "a method for identifying, analyzing and reporting patterns (themes) within data" (Braun and Clarke 2006: p. 79). Such an analysis demonstrates which topics are significant for describing the investigated phenomena (Daly et al. 1997). The thematic analysis process involves searching for and identifying common factors that span an entire interview or set of interviews (DeSantis and Ugarriza 2000). Agar (1980) emphasized classifying data to enable "objective" and "systematic" analysis. Accordingly, data must be examined and categorized based

on concepts emerging from the data, not external notions (Al-Debei and Avison 2010). The outcome of a thematic analysis should indicate the most predominant topics or constructs in the dataset (Joffe 2012).

More specifically, we examined the interview transcripts using Corbin and Strauss's coding guidelines (2008), wherein coding must be conducted at open, axial, and selective levels. Two coders completed the coding process. Because one of the coders was not involved in data collection, we were able to reduce the possibility of bias using this technique. During open coding, each coder examined interview transcripts line-by-line to avoid missing significant information and to identify key concepts to determine the main benefits and risks/concerns that influence the intention to use IRT-based FinTech in ATMs. Subsequently, both coders thoroughly discussed the 20 identified concepts and labeled them after reaching agreement.

Although open coding allows researchers to explore emerging concepts, axial coding helps examine, align, and improve the identified concepts in the form of different themes (Al Adwan 2017). Hence, we applied axial coding to relate, group, and categorize the concepts identified during open coding (Table 2) into seven broad themes (Wiesche et al. 2017). Each broad theme or category (Category-Level I; see Table 2) captures similarities and consistencies among the codes. As a result, we incorporated the concepts discovered into higher-order categories, which enabled us to develop fundamental theoretical structures. These theoretical structures were further investigated to determine the causal links that explain the intention to adopt IRT-based FinTech in ATMs following the NVF.

Selective coding was used to determine the important classes that contribute to the explanation of the research topic and to exclude extraneous aspects from the study. As shown in Table 2, axial coding yields seven distinct classes or themes. Selective coding is meant to reduce this number to two overarching categories: risks and benefits (Category-Level II; see Table 2) (Wiesche et al. 2017). Selective coding is important because it enables scholars to populate the desired categories and exclude superfluous categories (Holton 2007).

Analysis and results

The coding process of interview transcripts yielded 20 concepts (Table 2) from 364 related phrases or indices. From 185 indices, 10 concepts related to the benefits of using IRT-based FinTech in ATMs emerged, whereas 10 concepts emerged as risks from 161 indices. During axial coding, the emergent concepts identified during open coding were thematically synthesized into seven broad themes (Category-Level I), thereby advancing our development of key theoretical constructs.

Axial coding was employed to examine and establish associations among the central themes and concepts and to provide a specific picture of the nature of these associations (e.g., causal links). Therefore, seven generic categories or themes were determined: financial security benefit, convenience benefit, FinTech-enabled hygiene benefit, financial risk, physical risk, privacy risk, and performance risk. In the third phase of coding (selective coding), the central themes that could help understand the research area were identified and the unimportant categories were removed from further examination. The selective coding process resulted in two core categories: benefits and risks.

Table 2 Results of the coding process

Open coding (concepts)	Example comments	"Axial coding" (category-level I)	Frequency (percentage)	"Selective coding" (category-level II)
Physical safety issues Criminal activities	"Iris recognition might threaten my physical safety" "Criminals might try to obtain my iris or force me to scan my iris"	Physical risk	35 (10%)	Risks
Biometric system malfunction Inconsistency Poor surrounding conditions	"The biometric system might be unable to recognize my iris" "The biometric system's scanners might not work or be able to do their job at the time of use" "The scanner might be unable to recognize my iris in poor lighting ATMs" "The system might fail to recognize my iris in case of changes in eye condition due to illness or injury"	Performance risk	31 (9%)	
Potential monetary loss Financial Fraud Financial negative repercussions owing to technology faults	"This technology could be fooled by contact lenses or fake eyes, and I could lose the money in my account" "With this FinTech, identical twins might be able to access the same account, which could be bad for their finances" "I am not sure if a dead person's eye can be used to identify them, but if it does, it could cost a lot of money"	Financial risk	44 (13%)	
Unauthorized use of biometric information Improper storage of biometric information	"My biometric information might be stored poorly in banks' databases, and therefore make them subjected to theft and hacking" "My biometric information might be used without my consent"	Privacy risk	51 (15%)	
Hygienic authentication Contactless authentication	"Increased health and safety levels" "It is absolutely healthy process; I do not need to perform any physical contact to get recognized" "As contactless authentication, I have less concerns of getting infectious diseases"	FinTech-enabled hygiene benefit	57 (16%)	Benefits

Table 2 (continued)

Open coding (concepts)	Example comments	"Axial coding" (category-level I)	Frequency (percentage)	"Selective coding" (category-level II)
High level of security Fraud prevention Identity theft prevention	"With iris recognition I have less concerns having my PIN/password theft" "I would not be worried if my card got lost or stolen" "It is highly secure as it is difficult to have a scan of my iris" "With iris identification, the likelihood of account theft has decreased" "With iris recognition, I am the only authorized person who can physically access my accounts"	Financial security benefit	66 (19%)	
Ease of use Time saving Effort saving Cognitive effort saving Comfortability	"Iris recognition is an easy-to-use authentication process compared with other methods" "With iris recognition, I do not need to remember any PIN cods or passwords" "With iris recognition, I can access my account very quickly" "I do not need to hold my card to access my account"	Convenience benefit	62 (18%)	

The agreement between coders was determined using Cohen's Kappa coefficient and interrater agreement indices (McHugh 2012). The findings revealed that the interrater agreement was 88.2%, thereby indicating good agreement between the coders. Likewise, the value of Cohen's Kappa coefficient was 0.853, thereby showing a significant level of understanding and agreement between the coders. The decision factors presented in Table 3 show benefits (e.g., convenience benefit) and risks (e.g., privacy risk). We then confirmed the seven decision factors outlined in this study by exploring related literature. This process allowed us to derive the interconnection among the endogenous constructs and identified factors to finalize the study model, as described in the following section.

Research hypotheses

The subject of technology adoption is of utmost importance to IS investigations (Venkatesh et al. 2016), which focuses on how and why individuals choose technological services and applications, whether for personal or professional use. This line of inquiry is deemed imperative and pertinent due to the undeniable significance of technology in modern work and personal lives. Technology has radically changed how we live and conduct business; therefore, it is crucial to have a comprehensive

Table 3 Key decision factors

Interviewee	Risks				Benefits		
	Physical risk	Financial risk	Performance risk	Privacy risk	FinTech-enabled hygiene benefit	Convenience benefit	Security benefit
Interviewee 1		x	x	x	x	x	x
Interviewee 2	x	x		x	x	x	x
Interviewee 3		x	x	x		x	x
Interviewee 4			x	x	x	x	x
Interviewee 5	x	x		x			x
Interviewee 6			x		x	x	x
Interviewee 7				x			
Interviewee 8	x	x	x		x	x	x
Interviewee 9		x		x	x		x
Interviewee 10	x		x		x	x	x
Interviewee 11	x		x		x	x	x
Interviewee 12	x		x		x	x	x
Interviewee 13				x		x	x
Interviewee 14	x	x			x		x
Interviewee 15			x		x	x	x
Interviewee 16	x	x	x		x	x	x
Interviewee 17	x		x	x		x	x
Total/Percentage	9 (53%)	8 (47%)	11 (65%)	9 (53%)	12 (71%)	13 (77%)	16 (94%)

understanding of how consumers make decisions regarding technology adoption and use.

As previously noted, biometric technologies are contextual and controversial, and conventional technology adoption models and theories are not developed to handle such complexities and are thus unsuitable for application when examining the acceptance of such technologies (Byun and Byun 2013; Hossain and Dwivedi 2014; Breward et al. 2017; Liébana-Cabanillas et al. 2022). Accordingly, this study examines the adoption intention of IRT-based FinTech using the NVF, which is highly beneficial and significant for advancing the existing body of knowledge in the field of technology adoption. The introduction of new perspectives and paradigms to this domain complements existing knowledge using well-established theories and models, particularly when the phenomenon being studied is characterized as contextual and controversial.

In the first study, we addressed the contextual nature of biometric technology using qualitative exploratory research. Following the NVF, we investigated and cataloged the most significant benefits and risks of adopting IRT-based FinTech in ATMs as perceived by bank customers in Jordan. The results indicate that security, convenience, and hygiene were the most valued benefits, whereas the invasion of privacy, performance

failure, financial loss, and physical harm were the most feared risks. Because net valence (or "perceived value") is defined as the difference between total benefits and total risks, security, convenience, and hygiene benefits and performance, financial, privacy, and physical risks were deemed direct predictors of perceived value. In contrast, perceived value is regarded as a direct predictor of intention to adopt IRT-based FinTech in ATMs. Figure 1 presents the research model of this study.

Financial security benefit

In this study, the financial security benefit is attributed to the belief that IRT-based FinTech will protect clients' bank accounts from fraud and the risk of unauthorized access through ATMs (Chen et al. 2021). Previous research indicates that bank card (credit and debit cards) fraud, including their usage at ATMs, remains the topmost concern for consumers (Breward et al. 2017; Byun and Byun 2013; Sakharova 2012). Banks and consumers have reported fraudulent banking transactions conducted through ATMs, which cause serious monetary and nonmonetary losses to financial institutions, customers, and the economy (Mangala and Soni 2022; Morake et al. 2021).

The use of bank cards at ATMs is subject to potential fraud. For instance, a thief can capture personal identification information, such as PINs, by simply peering over a victim's shoulder and recording the PIN. More complex methods of ATM theft involve the use of concealed cameras to collect users' PINs or counterfeit card readers installed on actual machines to steal financial information electronically (Byun and Byun 2013). In comparison, the adoption of biometric technologies, such as fingerprints, facial recognition, and IRT, has the potential to eliminate these threats because these authentication methods use physical (i.e., biometric) traits that are unique to individuals (Morake et al. 2021; Breward et al. 2017; Byun and Byun 2013). This perception was supported

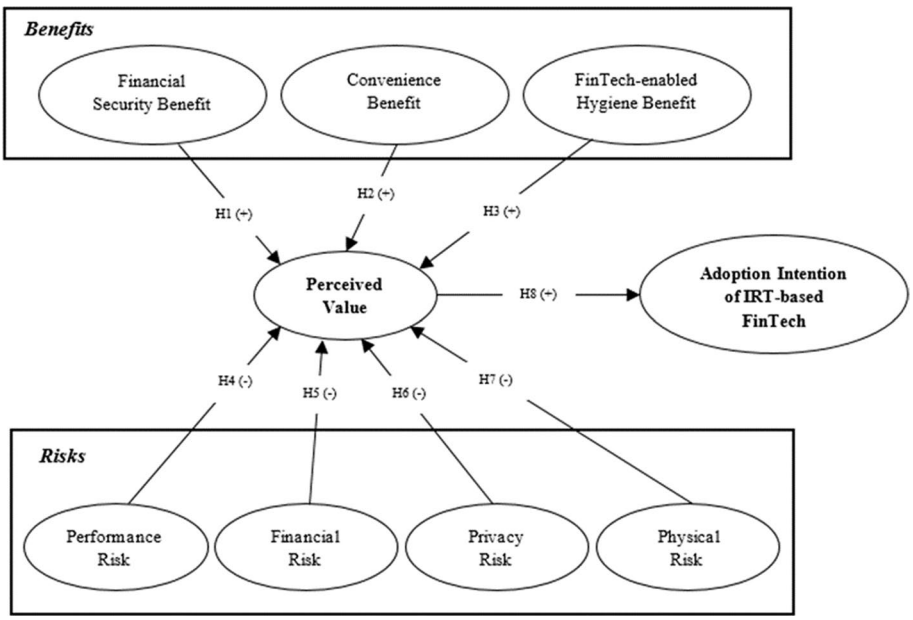

Fig. 1 Study model based on net valence framework (Breward et al. 2017; Sandhu et al. 2023)

by comments received from the participants in our qualitative study (Study 1), such as, "biometric-based systems can be labeled as innovative solutions that enable banks and clients to conduct financial transactions with five-star security and, therefore, with confidence," and "iris technology is unquestionably more secure than bank cards and PINs, which can be lost or stolen, sometimes without the owner's knowledge."

As a biometric authentication system, IRT offers advantages different from conventional authentication techniques based on "what we know," such as account and PIN codes, and "what we have," such as physical tokens. IRT relies on an analysis of an individual's iris, unlike PINs/tokens and other formats that can be misplaced, stolen, or traded (Klosterman and Ganger 2000). Because IRT data cannot be replicated, it is possible to differentiate between any two individuals, including identical twins. IRT authentication involves the subject's physical presence being verified because it compares an instant iris scan against a template consisting of previously acquired data. IRT reduces the likelihood of fraud and enhances customers' control and trust in banks. Byun and Byun (2013) found enhanced security to be one of the most common advantages of deploying biometric technologies in ATMs. Additionally, they identified a substantial relationship between perceived benefits and consumer value. Consequently, the following hypothesis is proposed:

H1 Financial security benefits positively and directly affect the perceived value of IRT-based FinTech in ATMs.

Convenience benefit

In the context of biometric technology, convenience benefit refers to a user's belief that IRT-based FinTech will simplify and streamline the process of accessing their bank account using an ATM (Breward et al. 2017). ATM users must recall specific information, such as PIN digits for identity verification. Because the number of credentials and codes that individuals must remember in today's digitally enabled society continues to rise, it is increasingly challenging to remember the correct access code for various computer-based platforms. For those who use ATMs for banking, problems with inputting the correct PIN can be inconvenient. After a set number of unsuccessful attempts to access the account with an erroneous PIN code (typically three), most banks block the card, and the outcome is be considered "customer-driven service failure" (Coventry et al. 2003; Byun and Byun 2013).

However, remembering the correct PIN code is insufficient to use an ATM; one's bank card must also be present. Individuals are required to retrieve their cards if they were unavailable before using the ATM; hence, substituting cards and PINs with IRT systems for ATM authentication promotes consumer convenience and comfort in three ways. It decreases the mental work necessary to recall PIN numbers, removes the possibility of service failure due to user error, and takes fewer resources to operate than existing ATMs because users simply need to be physically present. Incorporating IRT into a bank's services also saves customers time, which increases their convenience (Liébana-Cabanillas et al. 2022).

The use of biometric technology in ATMs, such as IRT-based verification systems, are user-friendly and expedite banking operations, thereby saving customers time (Breward et al. 2017; Al-Debei and Aloudat 2013). Participants in our qualitative study agreed with these insights and highlighted the convenience of biometric technologies by stating, "To me, iris scanning at ATMs is incredibly more convenient and simpler to use because it eliminates the need to remember PIN codes. There are too many additional passwords to remember for other applications, which is already a hassle."

Hence, using IRT would provide customers with perceived benefits in terms of convenience compared with the traditional system. Previous studies empirically confirmed this perception, which highlighted convenience as one of consumers' perceived benefits when using biometric systems in ATM machines (Breward et al. 2017; Byun and Byun 2013). Additionally, prior literature has shown that products, services, or technologies with higher convenience increase consumers' perceived value (Shahijan et al. 2018; Pham et al. 2018; Byun and Byun 2013). Thus, we propose the following hypothesis:

H2 Convenience benefits positively and directly affect the perceived value of IRT-based FinTech in ATMs.

FinTech-enabled hygiene benefit

"Hygiene" has its conceptual roots in public health literature. According to the World Health Organization, it refers to a series of practices and conditions that help prevent the spread of diseases, expressly through personal cleanliness (Vishwanath et al. 2020). This study defines FinTech-enabled hygiene benefit as the belief that contactless biometric technology, such as IRT-based FinTech, is hygienic and improves personal and public health safety. Considerable societal and community-level changes have occurred due to the impact of the COVID-19 pandemic on public health. Individuals have become increasingly aware that viruses and bacteria can be transmitted through commonplace human interactions, such as touching another person or an inanimate object that was touched by others. Consequently, many long-established practices involving physical contact are being reexamined.

During and after the COVID-19 pandemic, the use of contactless technologies to establish a safe environment for consumers and employees has become vital (Boo and Chua 2022; Pillai et al. 2021). The pandemic reoriented people's mindsets toward more preventive self-care because health issues directly affected individual behavior (Jiang and Wen 2020). Hence, for customer experience in terms of safety, cleanliness, and hygiene standards, the banking industry should embrace FinTech-enabled solutions to deliver contactless financial services.

Prior studies have demonstrated that clean and hygienic conditions impact consumers' attitudes and behavioral intentions (e.g., Shishah and Alhelaly 2021; Choi 2019; Zemke et al. 2015). Such awareness was evidenced through remarks in our qualitative study, such as, "As you are aware, COVID-19 has drastically altered our daily lives, particularly regarding our health and safety. People are really worried about the spread of coronavirus and other contagious diseases. Consequently, any technology that does not require physical contact, such as the iris, is favored in the context of the new healthy lifestyle."

Following these considerations, the current study is the first to establish the FinTech-enabled hygiene benefit as one of the salient advantages of employing biometric technology, specifically IRT-based FinTech. Unlike fingerprint authentication, IRT is a contactless technology that does not require any physical contact for customers. Thus, this technology is hygienic and can help prevent the transmission of infectious diseases, including COVID-19. Consumers now value and appreciate technologies that support measures to protect them from negative health consequences. Accordingly, the following hypothesis is proposed:

H3 FinTech-enabled hygiene benefits positively and directly affect the perceived value of IRT-based FinTech in ATMs.

Performance risk

Performance risk is defined as "the possibility that the product will not function as expected and/or will not deliver the desired benefits" (Grewal 1994: p. 145). Performance risk is considered the foundation for all facets of risk (Featherman and Pavlou 2003; Cunningham 1967). Existing literature indicates that performance risk is among the most frequently used dimensions for estimating risk (Kajol et al. 2022; Anwar et al. 2021; Yang et al. 2016). In addition, performance risk was found to negatively affect the perceived consumer value of using high-tech products or services, such as ride-sharing services (Wang et al. 2019), wearable devices (Yang et al. 2016), and biometric technologies (Byun and Byun 2013), because these products and services inherently involve unavoidable market and technological uncertainties (Yang et al. 2016).

With regard to biometric technologies, performance risk refers to the possibility that these technologies may not function as designed and advertised, thus failing to attain the anticipated benefits (Byun and Byun 2013). According to Langenderfer and Linnhoff (2005), customers are concerned that biometric technologies may fail during use even if no malicious intent is present. IRT's accuracy may suffer if an iris is obscured in any way, whether by lenses, eyelashes, eyeglasses, eyelids, or shadows/reflections (Norfolk and O'Regan 2020).

Consumers' perceptions of performance-related problems are of high importance because false acceptance errors in biometric technologies could lead to the risk of losing savings in bank accounts if the wrong customer is authenticated, whereas false rejection represents service failure (Byun and Byun 2013; Langenderfer and Linnhoff 2005). In the context of IRT-based FinTech adoption, interviewees who participated in our qualitative study highlighted concerns such as "Is the iris unique?," "Is the iris affected by age?," "Does it wear off like fingerprints?," "Is the iris affected by Lasik surgery or any other surgeries or diseases?," "Can IRT be used by individuals with different nationalities?," "Does IRT work for blind and one-eyed people?," "Is the IRT accurate?," and "How fast is the IRT?" These doubts and concerns indicate how customers' perceptions of performance risk may negatively affect the overall perceived value of IRT-based FinTech. Thus, this study proposes the following hypothesis:

H4 Performance risks negatively and directly affect the perceived value of IRT-based FinTech in ATMs.

Financial risk

Economists use the term "financial risk" to refer to the potential monetary cost of a product's initial purchase price and ongoing maintenance expenditures (Featherman and Pavlou 2003). Previous studies identified financial risk as one of the key components of overall perceived risk and found it to be negatively associated with consumer perceived value (Anwar et al. 2021; Yang et al. 2016; Agarwal and Teas 2004). Financial risk in IRT adoption is not associated with its initial purchase price because the customer does not usually pay an additional fee to use IRT. In this case, the financial risk is associated with the possibility that the user could lose money due to fraud or a false IRT match (Kajol et al. 2022; Norfolk and O'Regan 2020; Featherman and Pavlou 2003).

Notably, the significance of financial risk as one of the most vital factors that diminish consumers' perceived value of biometric technology in general and IRT-based FinTech in particular has been largely unexplored in previous research. However, according to our qualitative research, customers may be concerned about financial risks when using IRT-based FinTech in ATMs, which was demonstrated by respondent statements such as "Is the IRT secure such as using a password, or it can lead to financial losses?," "Contact lenses or fake eyes could fool this technology, and I could lose the money in my account," "With this FinTech, identical twins might be able to access the same account, which could be bad for their finances," and "I am not sure if a dead person's eye can be used to identify them, but if it does, it could cost a lot of money." These concerns demonstrate how customers' perceptions of financial risk may negatively affect the adoption intention of the IRT-based FinTech. Correspondingly, this study posits the following hypothesis:

H5 Financial risks negatively and directly affect the perceived value of IRT-based FinTech in ATMs.

Privacy risk

When an individual's information is exploited without their knowledge and consent, there is a risk of privacy loss (Sandhu et al. 2023; Kajol et al. 2022). The worst privacy risk scenario is spoofing, wherein a criminal acts as a legitimate consumer to conduct fraudulent transactions (Featherman and Pavlou 2003). Biometric systems require potential users to enroll to produce a biometric reference template; these templates are stored in a database during the enrollment phase (Morampudi et al. 2020). Although biometric authentication has been proposed to strengthen security, unprotected biometric data storage remains vulnerable to potential data breaches (Ogbanufe and Kim 2018).

Incidents have already occurred in advanced countries, wherein hackers stole 5.6 million fingerprint templates from the US government (Morampudi et al. 2020). Therefore, privacy risk, particularly identity theft, is a major concern for a potential adopter who may perceive that the biometric data collected from the iris scan or any other biometric technologies could be used for functions other than identification, thereby potentially

threatening privacy rights, such as searching in databases for information about individual actions, surveillance, or using data to profile individuals (Morampudi et al. 2020; van Greunen 2016).

Customers may be concerned that their biometric information will be leaked, misused, or disclosed to other parties without their permission (Boo and Chua 2022). For example, consumers may have concerns regarding the safety of their stored iris prints or whether iris prints may be used to recognize illnesses, drug use, or alcohol consumption. When biometric data is hacked or inadvertently released to unauthorized parties, the repercussions could be worse than a simple card or account password being compromised (Breward et al. 2017). Consumers can simply block or alter a bank card or PIN number, but if their biometric data have been compromised, the corrective measures are highly limited or nonexistent; therefore, such a breach is irrevocable (Breward et al. 2017; Langenderfer and Linnhoff 2005).

Issues related to consumers' privacy were also emphasized by participants in our qualitative study through statements and questions such as "Are there any regulations in Jordan to protect the collected customer's biological data?," "If biometric data is stolen by hackers, is it lost forever?," "How is biometric data handled and protected in the system?," and "I believe that once captured, clients cannot restrict the use of such biometric data, which is absurd." These privacy issues and concerns were found to negatively affect the perceived value of biometric technology (Byun and Byun 2013), including IRT-based FinTech. Given these arguments, this study hypothesizes the following:

H6 Privacy risks negatively and directly affect the perceived value of IRT-based FinTech in ATMs.

Physical risk

Physical (or health) risk refers to the perception that a product or service harms adopters (Wang et al. 2019; Lutz et al. 2018). Physical risk alludes to the potential that a criminal could compel victims to have their irises scanned, thereby making bank accounts more susceptible to identity theft (Byun and Byun 2013). Consequently, physical risks are increased, such as potential threats to consumers' health or physical safety. In addition, although iris scanning is argued to be safe because the system uses a high-definition camera to capture the iris (Daugman 2003; Du 2006), potential adopters may have health concerns due to a lack of familiarity with IRT or awareness regarding its effects on the human body. Consumers still question whether the iris imager is safe and could affect their health. Some users have expressed health concerns associated with biometric systems, such as eye damage or vision problems caused by the near-infrared ray emitted by iris scanners (Liébana-Cabanillas et al. 2022; Sabharwal 2016).

As demonstrated by our qualitative research, consumers are concerned that the IRT method may be harmful to their eyes and overall health. Examples of such issues include "How secure is the usage of this technology when close proximity to the iris scanner is required, given that there is radiation that could affect our eyes?," "Perhaps this technology poses health risks to pregnant women; for instance, does the imager employ a laser beam?," and "I am honestly uncertain as to whether iris

scanners are safe from a health standpoint, and this makes me worried." If unaddressed, such doubts may negatively influence consumers' value perceptions of IRT-based FinTech (Byun and Byun 2013). Hence, we hypothesize the following:

H7 Physical risks negatively and directly affect the perceived value of IRT-based FinTech in ATMs.

Perceived value

Perceived value is an important concept borrowed from the marketing field that has a crucial effect on consumer attitude, behavioral intention, satisfaction, and loyalty (Yu and Huang 2022). The concept is multidimensional and frequently combines consumers' cognitive and emotional perceptions regarding the use of products, services, or technologies in diverse contexts and circumstances (Cocosila and Trabelsi 2016; Al-Debei et al. 2022). Multiple conceptualizations of perceived value exist in the literature, and researchers appear to hold contrasting views regarding the concept (Yu and Huang 2022).

In this study, we adopted a prevalent definition of perceived value, which defines the concept as the user's appraisal of the value of a product or service based on what is "received" and "provided" (Zeithaml 1988). This conceptualization is appropriate to understand the acceptance of biometric technologies, which exemplify controversial technologies, and consider users' perceived gains and concerns from a net valence perspective (Breward et al. 2017). Additionally, the concept is congruent with the cost–benefit paradigm of behavioral choice theory (Johnson and Payne 1985; Al-Debei et al. 2022), which postulates that an individual considers the benefits/gains and costs (e.g., effort, time, and money) of employing a certain approach before making a decision. In other words, consumers typically evaluate the value of a technology, product, or service by considering its advantages and disadvantages (Breward et al. 2017; Cocosila and Trabelsi 2016; Byun and Byun 2013).

Based on the above discussion, we hypothesize that consumers' behavioral intentions to embrace IRT-based FinTech in ATMs will be higher if an activity is perceived to be connected with substantial added value (i.e., advantages outweigh sacrifices). Despite receiving minimal focus in the IS field, prior literature has provided objective evidence that perceived value positively promotes behavioral intention (Wisker 2022; Yu and Huang 2022; Al-Debei et al. 2022, 2013; Breward et al. 2017; Cocosila and Trabelsi 2016; Byun and Byun 2013; Kim et al. 2007). For instance, Byun and Byun (2013) demonstrated a substantial correlation between perceived value and customers' behavioral intentions to use biometric identification technologies in ATMs. Thus, we hypothesize that the perceived value associated with the use of IRT-based FinTech positively promotes consumer adoption intentions.

H8 Perceived value positively and directly influences consumers' adoption intentions of IRT-based FinTech in ATMs.

Study two: quantitative confirmatory study

Research methods and approach

The second study used a positivistic research philosophy to examine the phenomena empirically. To this end, the study employed an online survey to collect information from the respondents. The questionnaire was created and formatted as a Google form to collect data from banking customers online. Links were generated and shared on social media channels, including Facebook, Twitter, and LinkedIn.

The target participants for this study were banking customers in Jordan who use ATMs with their active accounts. This study collected information from respondents who were conveniently available (See Table 4). The reasons for using convenience samples include (1) a lack of sampling frame, as the Central Bank of Jordan restricts disclosing customer identities and (2) cost and time constraints in collecting information. Previous research on FinTech adoption in the context of developed and developing countries has also employed convenience sampling for data collection (Hasan et al. 2021; Alhajjaj and Ahmad 2022).

During the survey, the respondents were informed about the study's aims and their voluntary participation. We informed respondents that their information would not be shared and would only be used to fulfill the study objectives. Consequently, an initial sample of 673 was achieved, and the final valid sample included 631 respondents after a filtering procedure that excluded outliers and incomplete or pattern responses (see Table 4). This sample size is appropriate according to Kock and Hadaya's (2018) recommendation to determine the minimum sample size using the inverse square root criterion. This method refers to the probability that a test statistic's critical value is less than the ratio of a path coefficient to its standard error. We estimated that minimum sample sizes of 155 and 619 were required to attain a statistical power of 0.80 at a significance level of 0.05, assuming a minimum magnitude of 0.2 and 0.1 for path coefficients,

Table 4 Respondents' profile (n = 631)

Demographic		Frequency	Percentage (%)
Gender	Male	369	58
	Female	262	42
Age	18–24	122	19
	25–29	161	26
	30–39	173	27
	40–49	103	16
	> 50	72	11
Occupation	Employed	392	62
	Unemployed	56	9
	Student	115	18
	Others	68	11
Frequency of using ATMs (per week)	1–3	477	76
	4–7	132	21
	> 8	22	3
Educational level	High school or less	27	4
	Undergraduate Degree	503	80
	Postgraduate Degree	101	16

respectively. Our total sample size of 631 responses exceeds the aforementioned threshold, thereby forming an adequate sample size.

Other than the newly introduced hygiene benefit construct, all other measures used in this study were derived from well-established and previously validated research (see Appendix 1). However, we made minor adjustments to the original items to better adapt them to our research context. In particular, we made some changes to the wording of the adopted multi-item measures for our eight constructs to adjust them to the IRT-based FinTech context.

Before conducting the final survey, the face and content validity of the items were evaluated. To this end, we conducted interviews with five experts from academia and the field of FinTech to gather feedback concerning our research area, corresponding measures, and context. Based on their feedback, we determined some ambiguities in the items' wording and made minor alterations accordingly. In addition, a pre-test of the questionnaire was conducted with 50 banking customers to evaluate the wording, completeness, and order of the questions (Johanson and Brooks 2010). The feedback from the banking customers helped us refine ambiguous questions and modify the sequence and wording of the questionnaire, thereby further improving the questionnaire in terms of consistency, relevance, and clarity.

The final set of items with corresponding sources is presented in Appendix 1. As noted previously, the measurement items for the hygiene benefit construct were independently developed for this study. Despite the fact that all measurement items for all constructs included in the present study were subjected to various validity procedures, particular attention was paid to validating the measurement items used in the hygiene benefit construct to ensure its validity and applicability as a new construct introduced in this study. Therefore, the final version of the questionnaire comprised 33 questions, wherein 27 questions were related to 8 constructs and 6 questions were related to respondents' demographic information. The responses were gathered on a five-point Likert scale.

Furthermore, concerns associated with common method bias (CMB) were evaluated because the data for predictor and outcome variables were gathered through a single instrument. As has been noted that surveys may lead to biased judgments due to the changing moods of respondents, repetition of items, or related impacts (Podsakoff et al. 2003), we used Harman's single-factor analysis to address CMB (Podsakoff and Organ 1986). The results of the single-factor test indicate that all items corresponding to the eight constructs were loaded on an individual factor showing 39.86% of the total variance. Thus, the total variance brought by all items on a single factor is smaller than 50%, thereby indicating no CMB issue.

Data analysis and results

Using SmartPLS 3, structural equation modeling (SEM) was performed to investigate the proposed conceptual model paths (Ringle et al. 2015). SmartPLS is a popular software for analyzing the factor structure and relationships among constructs. Because this study sought to explore the impact of key constructs on the perceived value and adoption intention of IRT-based FinTech, partial least squares (PLS)-SEM was considered a better choice than covariance-based SEM (Hair et al. 2019).

The primary benefit of PLS-SEM is that it enables researchers to estimate complex models with multiple constructs, measurement indicators, and structural paths without making distributional assumptions regarding the data (Hair et al. 2019). In addition, as a causally predictive method, PLS-SEM stresses the estimation of statistical models that are intended to provide causal explanations. Therefore, PLS-SEM combines the goals of explanation, which is a common focus in academic research, with prediction, which is important to generate practical implications for management. This approach resolves the apparent conflict between these two objectives.

To employ PLS-SEM, two steps were followed, namely, assessments of the measurement and structural models (Anderson and Gerbing 1988). The measurement model allowed examining the validity and reliability of the variables, whereas the structural model assisted in determining the relationships among the proposed hypotheses.

Measurement Model SmartPLS 3 was employed to examine the validity and reliability of the variables and factor structures in the measurement model. Except PRR4, the

Table 5 Construct reliability and convergent validity

Construct	Item	Loading	α	rho_A	CR	AVE
Financial security benefit (SEB)	SEB1	0.901	0.914	0.917	0.940	0.796
	SEB2	0.914				
	SEB3	0.899				
	SEB4	0.852				
Convenience benefit (COB)	COB1	0.935	0.910	0.913	0.943	0.848
	COB2	0.877				
	COB3	0.948				
FinTech-enabled hygiene benefit (HYB)	HYB1	0.904	0.879	0.880	0.926	0.806
	HYB2	0.902				
	HYB3	0.887				
Performance risk (PER)	PER1	0.899	0.908	0.913	0.940	0.840
	PER2	0.940				
	PER3	0.910				
Financial risk (FIR)	FIR1	0.825	0.857	0.901	0.911	0.773
	FIR2	0.891				
	FIR3	0.919				
Privacy risk (PRR)	PRR1	0.893	0.894	0.897	0.934	0.825
	PRR2	0.942				
	PRR3	0.889				
	PRR4	0.502*				
Physical risk (PHR)	PHR1	0.869	0.891	0.897	0.933	0.822
	PHR2	0.930				
	PHR3	0.919				
Perceived value (PVA)	PVA1	0.883	0.916	0.918	0.941	0.800
	PVA2	0.876				
	PVA3	0.900				
	PVA4	0.917				
Adoption intention of IRT-based FinTech at ATMs (INT)	INT1	0.918	0.902	0.904	0.939	0.836
	INT2	0.913				
	INT3	0.912				

* Item deleted

Table 6 Fornell–Larcker discriminant validity test

	COB	FIR	HYB	INT	PER	PHR	PRR	PVA	SEB
COB	**0.921***								
FIR	−0.413**	**0.879**							
HYB	0.453	−0.421	**0.898**						
INT	0.356	−0.389	0.470	**0.914**					
PER	−0.068	0.010	−0.030	−0.016	**0.916**				
PHR	−0.328	0.452	−0.294	−0.408	−0.086	**0.906**			
PRR	−0.455	0.553	−0.546	−0.463	0.08	0.380	**0.909**		
PVA	0.547	−0.509	0.618	0.549	−0.062	−0.416	−0.595	**0.894**	
SEB	0.460	−0.381	0.570	0.451	−0.036	−0.314	−0.505	0.654	**0.892**

Bold indicates the diagonal numbers are the square roots of AVE

**The off-diagonal numbers are the correlation values among constructs

Table 7 Heterotrait–Monotrait test

	COB	FIR	HYB	INT	PER	PHR	PRR	PVA	SEB
COB	–								
FIR	0.456	–							
HYB	0.508	0.468	–						
INT	0.395	0.440	0.527	–					
PER	0.071	0.058	0.032	0.037	–				
PHR	0.367	0.540	0.332	0.454	0.106	–			
PRR	0.507	0.597	0.616	0.516	0.08	0.426	–		
PVA	0.597	0.551	0.687	0.601	0.063	0.457	0.655	–	
SEB	0.504	0.416	0.637	0.497	0.038	0.347	0.559	0.715	–

findings indicate that all measurement items had adequate reliability because all had a loading coefficient higher than 0.708 (Hair et al. 2019). The reliability of the constructs is ensured when the values of composite reliability, rho_A, and Cronbach's Alpha (α) are greater than the 0.70 threshold (Henseler et al. 2009). These conditions were met, as demonstrated in Table 5. Furthermore, convergent validity was examined by calculating the value of average variance extracted (AVE) for each construct. Table 5 shows that convergent validity is established because all AVE values are larger than 0.5, thereby indicating that the items converge to the intended theoretical constructs (Hair et al. 2019).

Finally, we examined the discriminant validity of the constructs. As seen in Table 6, all AVE values are higher than the parallel shared variances, whereas the Fornell–Larcker standard shows that the square roots of AVEs are higher than the corresponding correlations, thereby ensuring discriminant validity (Fornell and Larcker 1981). In addition, we employed the Heterotrait–Monotrait ratio (HTMT) standard to evaluate the constructs' discriminant validity. Table 7 reveals that the HTMT ratios are smaller than the cut-off value of 0.85, thereby indicating discriminant validity (Henseler et al. 2015). The present study's discriminant validity was also established by cross-loading (see Appendix 2), which indicates that all items were substantially loaded on their respective constructs.

Structural Model The hypotheses were analyzed using structural model estimation. The analysis incorporated the assessment of lateral multicollinearity, path coefficients

Table 8 Summary of hypotheses testing

Hypothesis	β	Bias-corrected confidence intervals (95%)	Mean	STDEV*	T statistics	P values
H1: SEB—> PVA	0.312	[0.194, 0.430]	0.309	0.061	5.109	0.000
H2: COB—> PVA	0.161	[0.074, 0.263]	0.160	0.049	3.309	0.001
H3: HYB—> PVA	0.209	[0.097, 0.326]	0.211	0.059	3.545	0.000
H4: PER—> PVA	− 0.029	[− 0.078, 0.021]	− 0.029	0.025	1.138	0.255 ns
H5: FIR—> PVA	− 0.106	[− 0.187, − 0.031]	− 0.106	0.039	2.690	0.007
H6: PRR—> PVA	− 0.151	[− 0.244, − 0.058]	− 0.152	0.047	3.201	0.001
H7: PHR—> PVA	− 0.101	[− 0.168, − 0.036]	− 0.103	0.034	3.001	0.003
H8: PVA—> INT	0.549	[0.470, 0.622]	0.553	0.039	14.139	0.000

**STDEV* Standard deviation; *ns* not significant

(β), t-value, and p-value for each hypothesized path in addition to the value of the coefficient of determination (R^2), predictive relevance (Q^2), effect size (f^2), and the predictive performance (Q^2_predict) of the research model (Hair et al. 2019). Concerns related to lateral multicollinearity were examined using the variance inflation factor (VIF). According to Becker et al. (2015), a value of VIF < 3 indicates no signs of multicollinearity. Table 9 reveals that the VIF values of all independent variables are < 3 when compared with dependent variables; thus, this study has no lateral multicollinearity problem.

The proposed hypotheses (paths) were tested by examining the path coefficients (β) with corresponding t- and p-values. Bootstrapping in SmartPLS can reduce normality concerns. Hence, the bootstrapping procedure was performed with a resampling of 5000 (Hair et al. 2019). As indicated in Table 8, except H4, all hypotheses were supported, as the effect of PER on PVA was found to be insignificant (β = − 0.029, p-value = 0.255). Additionally, SEB had the strongest positive effect on PVA (β = 0.312, p-value ≤ 0.001), thereby revealing that financial security benefit plays a key role in forming banking customers' perceived value of IRT-based FinTech.

Next is the significance of the FinTech-enabled hygiene benefit in forming customers' perceived value (β = 0.209, p-value ≤ 0.001). This finding confirms the results of the qualitative study, thereby suggesting that customers are increasingly concerned about the cleanliness of technology in the wake of the COVID-19 pandemic and spread of other contagious diseases. This is a significant contribution to the literature because this topic has not been previously investigated.

Finally, COB was found to have a positive effect on PVA (β = 0.161, p-value ≤ 0.001), thereby indicating that convenience benefit is an important enabler of the perceived value of IRT-based FinTech. Conversely, the strongest negative effect on PVA was generated by PRR (β = − 0.151, p-value ≤ 0.001), thereby indicating that privacy risk is a key factor diminishing customers' perceived value of IRT-based FinTech. The second-ranked risk construct is financial risk (FIR) (β = − 0.106, p-value ≤ 0.001). The final significant risk factor that negatively affects customers' perceived value is physical risk (PHR) (β = − 0.101, p-value ≤ 0.01). Finally, PVA was found to have a significant positive effect on INT (β = − 0.549, p-value ≤ 0.001), thereby indicating that perceived value is the primary facilitator of banking customers' intention to adopt IRT-based FinTech in ATMs.

Table 9 Evaluation of VIF, R^2, f^2, Q^2, and Q^2_ Prediction

	VIF	R^2	f^2	Q^2	Q^2_predict
PHR	1.349	–	0.019	–	–
INT	–	0.302	–	0.249	0.307
COB	1.491	–	0.044	–	–
FIR	1.665	–	0.017	–	–
PER	1.027	–	0.002	–	–
PRR	1.901	–	0.030	–	–
SEB	1.699	–	0.146	–	–
HYB	1.780		0.063	–	–
PVA	1.000	0.609	0.432	0.474	0.586

R^2 values as an indication of predictive power were evaluated. R^2 coefficients of 0.25, 0.50, and 0.75 are considered weak, moderate, and substantial, respectively (Hair et al. 2019). The R^2 values of the research model's endogenous constructs of PVA ($R^2 = 60.9\%$) and INT ($R^2 = 30.2\%$) indicate satisfactory explanatory powers (see Table 9). Additionally, the strength of the study constructs was evaluated through effect size (f^2) analysis, which reveals any changes in R^2 by an independent variable (Cohen 1988). This study considered three values to determine effect size, namely, small (0.02), moderate (0.15), and substantial (0.35). The results concerning effect sizes presented in Table 9 indicate that SEB has the largest effect size (0.146) in shaping PVA compared with all other constructs, as they all have a small effect size on PVA. In addition, PVA influences INT with a large effect size (0.432).

We also performed a blindfolding procedure to examine the predictive relevance (Q^2) of the study model, with an omission distance of 8 ($D = 8$). According to Hair et al. (2019), Q^2 values greater than 0, 0.25, and 0.50 reflect the small, medium, and large predictive relevance of the path model in PLS-SEM, respectively. The adoption intention of IRT-based FinTech exhibited nearly moderate predictive relevance ($Q^2 = 0.249$), whereas the perceived value construct demonstrated medium to large predictive relevance ($Q^2 = 0.474$).

The predictive performance of the study model was analyzed and validated by incorporating the PLSpredict algorithm, with 10 folds and 10 repetitions. PLSpredict evaluates predictive performance in terms of the power and consistency of out-of-sample predictions from the research model. According to Hair et al. (2019), acceptable predictive performance can be achieved when Q^2 prediction values are greater than 0. The findings in Table 9 indicate that Q^2 prediction values are greater than 0, thereby demonstrating that the study model has a strong capacity for predicting customers' perceived value of and, consequently, their intention to embrace IRT-based FinTech in ATMs. Then, we compare the root mean squared error (RMSEA) values of the PLS-SEM model and a naïve benchmark, which is a linear regression model (LM) of all measures of the endogenous constructs, to further assess predictive performance. As shown in Table 10, the comparison results demonstrate that PLS-SEM has lower prediction errors (i.e., RMSEA) than LM, thereby confirming the high predictive performance and influence of the study model (Shmueli et al. 2019).

Table 10 PLSpredict statistics

Indicators of endogenous latent construct	RMSE_PLS	RMSE_LM	Is RMSE_PLS < RMSE_LM?
INT1	0.419	0.422	Yes
INT2	0.423	0.425	Yes
INT3	0.420	0.424	Yes
PVA1	0.352	0.361	Yes
PVA2	0.430	0.326	No
PVA3	0.375	0.383	Yes
PVA4	0.368	0.389	Yes

Table 11 Evaluation of indirect effects

Indirect path	β	Bias-corrected confidence intervals (95%)	Mean	STDEV*	T statistics	P values
COB—> PVA—> INT	0.088	[0.041, 0.140]	0.089	0.026	3.459	0.001
HYB—> PVA—> INT	0.115	[0.053, 0.053]	0.116	0.034	3.366	0.001
PER—> PVA—> INT	− 0.016	[− 0.045, 0.012]	− 0.016	0.014	1.101	0.271
PHR—> PVA—> INT	− 0.056	[− 0.097, − 0.019]	− 0.057	0.02	2.813	0.005
PRR—> PVA—> INT	− 0.083	[− 0.144, − 0.031]	− 0.084	0.028	2.92	0.004
FIR—> PVA—> INT	− 0.058	[− 0.105, − 0.017]	− 0.059	0.022	2.599	0.009
SEB—> PVA—> INT	0.171	[0.110, 0.232]	0.17	0.032	5.401	0.000

**STDEV* Standard deviation; *ns* Not significant

Evaluation of indirect effects

Table 11 presents the significance of indirect effects in the proposed model. As the results suggest, all possible indirect effects were significant. The strongest indirect effect was generated from SEB on INT through PVA ($\beta = 0.171$, p-value ≤ 0.001). This suggests that the increase in SEB can positively influence INT by strengthening PVA. On the other hand, the weakest significant effect was from PHR on INT through PVA ($\beta = -0.056$, p-value ≤ 0.05). This indicates that the increased PHR negatively influences INT by decreasing PVA. Expectedly, the indirect effect of PER on INT through PVA was significant (-0.016, p-value > 0.05).

Discussion and implications

This research was motivated by four primary factors. First, despite the growing availability of FinTech products and services, customer acceptance of these innovations remains rather low, particularly in the Arab world, including Jordan. This low acceptance is more evident in the case of IRT-based authentication systems, which are controversial according to customers. Second, there is a substantial void in the literature regarding the examination of controversial technology, particularly biometric-based FinTech. Third, there is a dearth of studies on IRT-based FinTech in the IS literature; most existing research addresses the topic from purely technical and computing perspectives. Consequently, it is essential to understand how customers form adoption intentions for such controversial technology.

In addition, when examining the adoption and acceptance of controversial technologies, motivators and benefits should be considered and the impediments to adoption in the form of risks and concerns must be given significant importance. Furthermore, the more controversial the technology, the higher the influence of the risks on customer acceptance; therefore, this study established a theoretical foundation based on the NVF, which asserts that customer adoption of controversial technologies is based on three distinct decision-making techniques: risk perception, perceived return, and a net valence or perceived value strategy. Accordingly, this study is instrumental in expanding the body of knowledge related to technology adoption and acceptance.

Nonetheless, it is also problematic to investigate the adoption of any biometric technology without considering its context in terms of culture, the biometric technology in use, and use scenarios. For instance, Riley et al. (2009) conducted a cross-cultural study to investigate users' attitudes toward biometric technology and discovered that Indian respondents evaluated biometric technology more positively in terms of security, ease of use, and speed than their British and South African counterparts. In addition, research indicates that customers' views of the advantages and disadvantages of biometric technology can vary depending on the biometric devices deployed (Liébana-Cabanillas et al. 2022; Byun and Byun 2013; Alterman 2003). For instance, consumers have negative perceptions regarding IRT compared with fingerprint systems due to health-related risks (i.e., effect on vision), although they evaluated IRT as the most secure biometric technology for user authentication (Liébana-Cabanillas et al. 2022; Byun and Byun 2013; Furnell and Evangelatos 2007). Recognizing the importance of context, this study identified Jordan as the social and cultural setting, IRT-based FinTech as the biometric technology in use, and ATMs as the use case.

Jordan provided an excellent social and cultural setting for the current study because FinTech is advanced in Jordan but its adoption and acceptance are relatively untapped compared with the developed world. Given the contextual nature of IRT-based FinTech, it is reasonable to assume that the factors that encourage or dissuade customers in Jordan from using IRT-based FinTech may differ from those in developed nations. This constitutes the fourth motivation for this study, which aimed to investigate the primary benefits and risks associated with the use of IRT-based FinTech in ATMs from the perspective of Jordanian customers, who differ from their Western counterparts from social, cultural, and economic perspectives.

Discussion of the qualitative study and theoretical implications

Following a qualitative approach that employed semi-structured interviews, the first study aimed to explore the salient benefits and risks associated with the use of IRT-based FinTech in ATMs from the perspective of Jordanian customers. As a result, seven exogenous constructs emerged from a content analysis of the transcriptions of customers' perspectives on the use of IRT-based FinTech in ATMs, with three constructs as benefits (i.e., financial security, convenience, and the newly introduced FinTech-enabled hygiene benefit) and four risk constructs (i.e., performance, financial, privacy, and physical risk).

Regarding benefits, our qualitative study revealed that the financial security benefit was the most commonly highlighted, as 16 out of 17 interviewees (94%) acknowledged

this benefit. Examining the number of codes/indices associated with each exogenous construct that emerged from the content analysis process also indicated that the financial security benefit was associated with the greatest number of codes/indices (66 out of 346 or 19%). This gives additional proof that the financial security benefit is considered the most prominent advantage of using IRT-based FinTech in ATMs from Jordanian customers' perspective.

This particular finding is consistent with previous research examining the use of biometric technologies in the financial sector. For instance, by extending the TAM, James et al. (2006) identified the "perceived need for security" as one of the most substantial advantages of biometric technologies. In addition, Byun and Byun (2013) identified "increased security" of financial transactions in terms of the uniqueness and reliability of fingerprint biometric technology in ATMs compared with cards/PINs as a major advantage, based on a comprehensive literature review and informal personal interviews with 20 customers of a nonprofit credit union in the US. Furthermore, based on a qualitative survey of bank customers in the US, Breward et al. (2017) showed that "account security" is a prominent benefit associated with the use of biometric technology (i.e., fingerprints) for accessing financial data.

Next is the convenience benefit, which was recognized by 13 interviewees (77%) in over 62 codes/indices (18%). Existing literature also underlines the benefit of convenience when biometric technology replaces PINs for accessing financial data through ATMs. For instance, James et al. (2006) revealed that the perceived ease of use, as a reflection of convenience, is a motivating variable influencing customer acceptance of biometric technologies. Furthermore, in a qualitative study, Breward et al. (2017) demonstrated that convenience, "as the belief that the technology (biometric identity authentication) will make the task of accessing one's bank account through an ATM quick and easy," is one of the most significant advantages of using biometric technology in ATMs.

Byun and Byun (2013) used two constructs of "cognitive-effort saving" and "time convenience" to reflect convenience benefits. In their study, cognitive-effort saving implied the absence of mental effort required to remember PINs and time convenience referred to the time saved when fingerprints are used by ATMs instead of PINs to authenticate customers. Similarly, Liébana-Cabanilla et al. (2022) examined the adoption intention of iris scan payment using mobile phones by employing two convenience-related constructs in their study model, namely, "effort expectancy," which refers to "the degree of ease associated with the use of the system," and "convenience," which implies "the extent to which consumers consider it to be desirable for the efficient performance of a task." Accordingly, previous studies used constructs such as "performance expectancy/perceived usefulness" and "effort expectancy/perceived ease of use" to exemplify the convenience advantages of using biometric technologies for payments (Moriuchi 2020; Wang 2021).

From this perspective, the findings of the present study are more consistent with those of Breward et al. (2017), as unlike other studies that impose the concepts externally, both studies initially conducted qualitative investigations from which convenience-related benefits were conceptualized within a single theme or category. This is essential because it implies that future research must address the benefits associated with time saving,

mental-effort saving, and accessibility under a single theme or construct because they are not mutually exclusive.

Furthermore, based on our qualitative study, the final pertinent benefit is FinTech-enabled hygiene benefit, which was identified by 12 interviewees (71%) and indicated by 57 codes/indices (16%). The emergence of this concept is regarded as one of the study's novel contributions, as it has not been previously observed. The qualitative study indicated that customers are now more concerned with the hygiene aspects of technology perhaps as a result of the COVID-19 pandemic and the advent of other contagious diseases, such as the monkeypox virus.

Our results revealed that customers feel safer when using IRT-based FinTech in ATMs as a contactless modality because they can be authenticated from a distance, thereby preventing the spread of infectious diseases due to the lack of physical contact. We assert that hygiene is no longer a requirement solely for pharmacies, medicine, and hotels. In addition to the food and beverage industry, hygiene-related considerations have become a top priority for customers in nearly every aspect of customer-facing businesses.

Due to the novelty of the FinTech-enabled hygiene benefits of biometric technology, no previous study has examined the impact of this factor on technology acceptance. Therefore, by introducing this original construct, we assert that this study significantly adds to the corpus of knowledge on technology acceptance. This ground-breaking concept can spark further exploration in the IS field and inspire new discoveries, refinements, and developments to advance existing knowledge.

In addition, the literature analysis revealed that some previous studies combined two or more benefits associated with the use of biometric systems in the financial sector into a single concept. For instance, Palash et al. (2022) used the concept of "relative advantage," which was borrowed from the diffusion of innovation theory, to express security and convenience advantages, whereas Liu et al. (2021) used the construct of "perceived benefits" to define the total gains from biometric technology, including tailored services, enjoyment, and perceived rewards.

Furthermore, the qualitative study revealed major risks associated with adopting IRT-based FinTech in ATMs. Despite the fact that one of the primary motivations for banks to deploy and customers to use biometric technologies in general and IRT-based FinTech in particular is to significantly increase the security of financial transactions and improve the level of convenience and hygiene, customers still perceive that such technologies pose threats and raise concerns regarding their private, personal, and financial information.

Perceived risks and concerns related to the use of biometric technologies in the financial sector have been analyzed in previous literature (Moriuchi 2020; Norfolk and O'Regan 2020; Lee and Pan 2022; Palash et al. 2022). According to our analysis, the first risk factor identified was performance risk, which 11 interviewees (65%) indicated as the most prominent risk associated with the adoption of IRT-based FinTech in ATMs. This was followed by privacy and physical risks, both of which were indicated by nine interviewees (53%. Finally, only eight respondents (47%) cited financial risk as a primary concern or threat.

Examining the number of codes/indices associated with each risk construct that resulted from the content analysis based on the number of interviewees who

acknowledged the construct demonstrated that the relative importance of each risk construct differed considerably from the ranking. According to the number of codes/indices, privacy risk was the most significant (51 codes/indices; 15%), followed by financial risk (44 codes/indices; 13%), physical risk (35 codes/indices; 10%), and performance risk (31 codes/indices; 9%).

In general, the results of our qualitative analysis in terms of risks are consistent with those of previous relevant studies and expand upon them. Prior research on the acceptance of fingerprint biometric technology in ATMs has revealed that one of the greatest concerns from the customer perspective is privacy risk, which suggests that identity theft and unauthorized use may occur when financial institutions maintain customers' personal and private biometric profile data in registries for comparison (Byun and Byun 2013; Breward et al. 2017; Liu et al. 2021; Lee and Pan 2022; Palash et al. 2022). For instance, customers are concerned that biometric scanners may be connected to government databases, including criminal arrest records (James et al. 2006). This is consistent with our findings, which indicate that customers' use of IRT-based FinTech in ATMs poses a significant privacy risk. Despite the fact that the technology used in the present study (IRT-based FinTech) is distinct from that analyzed in prior research (fingerprints), the privacy risk remains considerable, which suggests that privacy risks and concerns remain significant when evaluating the broad acceptance of biometric technologies, regardless of the technology employed.

In addition, our qualitative research reveals that deploying IRT-based FinTech in ATMs was perceived to expose customers to substantial financial risks; financial risk has not been previously identified as a distinct construct in the relevant literature, thereby making its identification one of the study's key contributions. Financial risk refers to the possibility of financial loss for the user due to iris recognition fraud or a false match (Featherman and Pavlou 2003; Norfolk and O'Regan 2020). Consequently, users are particularly concerned that the use of such technologies could have significant repercussions for their bank accounts.

Financial risk is the exact opposite of the previously identified financial security benefit, which demonstrates how controversial IRT-based FinTech is. Although customers perceived that the use of IRT-based FinTech may provide higher levels of security, they were simultaneously concerned that the adoption of such technology may compromise their bank accounts. Given the newness of this construct, investigating its impact on perceived value and the subsequent intent to adopt IRT-based FinTech would be significant for academics and practitioners.

The next risk factor from the perspective of the customers who participated in our qualitative study was physical risk, which is also largely unexplored in extant literature. In fact, our literature review discovered only one study that examined physical risks associated with the use of biometric technologies in ATMs (Byun and Byun 2013). Our qualitative investigation found that customers were concerned about their health owing to perceived potential threats to their physical safety due to the use of IRT-based FinTech in ATMs.

The study revealed that customers evaluated physical risk in terms of two different dimensions. The first dimension relates to potential physical violence perpetrated by criminals to obtain a victim's retinal tissue or compel them to scan their iris, and the

second dimension relates to the harmful impact that the iris imager could have on the eye or human body as a whole. This finding is consistent with that of Byun and Byun (2013), who examined the use of fingerprints in ATMs. Similar to privacy risk and based on the qualitative findings, we contend that perceived physical risk from potential violent acts committed by criminals remains viable across all biometric technologies.

The last acknowledged risk factor was performance risk. Despite the fact that IRT is considered a unique and expedient authentication mechanism that does not degrade over time, our analysis revealed that its drawbacks from the customers' perspective could be related to its precision, efficiency, and resilience as well as the operational/environmental factors that could influence these characteristics. Previous research has indicated that the operational and functional dimensions of biometric technology may impede their acceptability and use in the financial sector. For example, Byun and Byun (2013) demonstrated that the use of fingerprints in ATMs posed performance risks in the form of mismatching flaws, malfunctions, and imprecision due to technological, environmental, and human aging factors. Furthermore, Lee and Pan (2022) observed that "system feature overload," referring to psychological shifts among users and system complexity, "technology uncertainty," referring to the unpredictable nature and implications of technological progress, and learning and education about these advancements are performance-related challenges associated with the use of facial recognition payment services. In addition, Palash et al. (2022) adopted "perceived complexity" to highlight the performance-related problems associated with feature overload and the difficulty of using facial recognition for facilitating payments.

Finally, based on the results of the qualitative investigation, it is apparent that the ranking of benefits by importance is stable, regardless of whether it is based on the number of interviewees who acknowledged a construct or the number of indices associated with a construct, whereas the ranking of risks by importance varies significantly across approaches. Furthermore, our analysis revealed that the interviewees discussed the benefits more extensively than the risks associated with the use of IRT-based FinTech in ATMs. This finding is based on the fact that the overall number of codes/indices related to benefits was 185 (54%), whereas the total number of codes/indices related to risks was 161 (46%).

Discussion of the quantitative study and practical implications

According to our results and from a positive valence perspective, customers' perceptions of the value of IRT-based FinTech in ATMs are predominantly focused on its financial security, hygiene, and convenience benefits; thus, H1, H2, and H3 are supported. This implies that participants considered improved security, hygiene, and convenience to be the most relevant aspects in determining the perceived value of IRT-based FinTech in ATMs.

The bank customers regarded IRT-based FinTech as providing better security as well as hygienic and convenient service compared with traditional ATM services, such as cards/PINs, QR codes, or NFC. However, although prior research on biometric recognition technologies confirmed the positive effect of financial security and convenience benefits on the acceptance of biometric technologies in the financial industry (James et al. 2006; Byun and Byun 2013; Breward et al. 2017; Moriuchi 2021; Wang 2021; Liébana-Cabanilla

et al. 2022), the positive effect of the FinTech-enabled hygiene benefit on the perceived value of biometric technologies has not been investigated. Importantly, the present study found that users value the contactless aspect of IRT-based FinTech in ATMs, which protects against infectious diseases, particularly in light of the recent spread of COVID-19 and monkeypox.

Among these gains, the financial security benefits of using IRT-based FinTech in ATMs are most significant ($\beta = -0.312$, p-value ≤ 0.001). This study indicated that banking customers may be driven to embrace IRT-based FinTech in ATMs due to their high security advantages, which indicates utilitarian value in the form of increased protection and bank account security.

In contrast, the results revealed that convenience is the least crucial factor for Jordanian customers for using IRT-based FinTech in ATMs ($\beta = 0.161$, p-value ≤ 0.001). Although IRT-based FinTech in ATMs may be convenient in practice, initiating a transaction may still involve some mental effort on the customer's part. In particular, when using a regular ATM that is not equipped with IRT-based authentication, customers will still need to use bank cards and remember and input PINs. This is especially true when a bank's ATM network is not entirely equipped with an IRT-based identification system.

Therefore, Jordanian banks considering the implementation of IRT-based FinTech in ATMs should focus their marketing efforts on educating customers and raising awareness regarding the benefits of the technology, such as increased security, hygiene, and convenience, compared with other forms of identity verification. Furthermore, we contend that Jordanian banks that have implemented IRT-based authentication systems in their ATMs must equip their entire ATM network with this technology, not just a subset, to boost customers' perceptions of convenience and promote the wider adoption of IRT-based FinTech in ATMs.

This study also examined the impact of various perceived risks on the perceived value of IRT-based FinTech adoption in ATMs from the perspective of negative valence. The results revealed that privacy, financial, and physical risks had significant negative effects on the perceived value of using IRT-based FinTech in ATMs. These findings are consistent with previous literature that confirmed the negative effect of such risks on adopting biometric technologies (Palash et al. 2022; Liu et al. 2021; Byun and Byun 2013). Thus, H5, H6, and H7 are supported.

Among the four types of risk identified in the research model, privacy risk was deemed to be the most significant for participants, which influenced their perceptions of the value of IRT-based FinTech in ATMs ($\beta = -0.151$, p-value ≤ 0.001). We assert that the novelty and originality of IRT-based FinTech in ATMs as controversial technology increases Jordanian customers' skepticism regarding the use of the technology, particularly in terms of consumer privacy. Therefore, a potential breach of biometric data, whether unintended or deliberate, reduces the perceived value of deploying IRT-based FinTech in ATMs for customers in Jordan. This is justifiable because customers perceive a loss of control over their biometric data when the bank records it, thereby leading them to question the potential uses and confidentiality of their biometric information.

However, regarding the impact of privacy risk on customers' acceptance of biometric technologies in the financial industry, previous research has produced contradictory results. Contrary to most existing research (Breward et al. 2017; Moriuchi 2020; Wang

2021; Liu et al. 2021; Palash et al. 2022; Lee and Pan 2022) including the present study, Byun and Byun (2013) demonstrated that privacy risk was not a significant barrier for nonadopters to use fingerprints at ATMs in the US. This inconsistency in results can be explained by variations in societal or cultural contexts, the biometric technology employed, and the use cases examined because biometric technologies are largely contextual in nature, as previously discussed.

Several practical implications can be derived from privacy risk. If customers are not provided with a clear privacy policy by their bank, they are likely to perceive the confidentiality of their personal information to be compromised. For instance, individuals' biometric data should not be used in ways that are inconsistent with the original aim of acquisition. Banks that use biometric technologies should take sufficient precautions to prevent unauthorized access, destruction, modification, or distribution of biometric data. Biometric data privacy policies that specify how customers' recorded irises are saved, maintained, retrieved, and protected from potential security threats can ease consumers' privacy risk concerns. The absence or inadequacy of laws and regulations governing the use and storage of biometric data in the financial industry of a country also contributes to the skepticism regarding biometric technologies. Hence, it would be advantageous for banks to independently establish rules and policies regarding the use of biometric data. When laws and policies foster trust, consumers will be less hesitant to use biometric technologies, such as IRT-based FinTech in ATMs.

As previously mentioned, one of the most significant contributions of this study is the introduction of financial risk as a prominent construct influencing customers' perceived value of IRT-based FinTech in ATMs, based on our qualitative investigation. This study extends the construct by examining the effect of financial risk on perceived value, thereby revealing it to be a significant concern that could hinder customers' use of such biometric technology in Jordanian ATMs ($\beta = -0.106$, p-value ≤ 0.001). Therefore, banks must offer customers guarantees and assurances regarding any form of exposure to financial risk. In this context, to provide customers with greater financial sustainability and protect them from financial fraud or monetary loss, we recommend implementing a chargeback mechanism similar to that used for credit card disputes. Offering customers the option to submit chargebacks on fraudulent IRT-based transactions in ATMs will eliminate risk and encourage the use of biometric technology.

In contrast to the results of Byun and Byun (2013), this study confirmed the significance of physical risk in discouraging Jordanian customers from using IRT-based FinTech in ATMs ($\beta = -0.101$, p-value ≤ 0.01). Byun and Byun (2013) concluded that physical risk was not a significant barrier to US customers' use of fingerprints in ATMs. As previously noted, the contextual nature of biometric technologies enables variation in results across contexts and settings.

Nevertheless, the significance of physical risk in diminishing the perceived value of IRT-based FinTech among Jordanian customers suggests that banks in Jordan should establish measures to protect the physical safety of their customers from criminals as much as possible. This could be accomplished by enabling customers to make seamless and speedy emergency calls from any ATM location. In addition, the presence of CCTV can reduce the probability of criminal activity. Furthermore, it is recommended that banks equip ATMs with a key that identifies fraudulent activity (such as a forced

transaction by a criminal), blocks a customer's account, captures a photo of the criminal, and communicates these details directly to law enforcement. These safeguards would significantly reduce the physical risks associated with the use of IRT-based FinTech in ATMs.

Our quantitative analysis revealed that the relationship between performance risk and perceived value is statistically insignificant; therefore, H4 is not supported. This finding about the influence of performance risk on the acceptance of biometric technology is consistent with Palash et al. (2022), who found that system complexity is not a major predictor of the intention to use facial recognition for payments in China. In addition, technology uncertainty and system feature overload have been demonstrated to substantially impact technostress and, consequently, the unwillingness to adopt facial recognition payment services in China (Lee and Pan 2022). Conversely, prior research on biometric recognition systems has indicated that performance risk has a substantial impact on perceived risk and subsequent customer value (Byun and Byun 2013). These disparities may be attributable to contextual variations.

Finally, perceived value was found to positively influence the intention to adopt IRT-based FinTech in ATMs ($\beta = -0.549$, p-value ≤ 0.001), thereby supporting H8. This indicates that the higher the perceived value of IRT-based FinTech in ATMs is, the greater the intention will be to use it. This result is supported by previous studies (e.g., Byun and Byun 2013).

Although there are some risks associated with using IRT-based FinTech in ATMs as controversial technology, the participants indicated that implementing this technology could lead to superior and valuable outcomes that outweigh the risks associated with IRT-based FinTech, thereby resulting in a positive orientation toward its implementation in ATMs. Consequently, based on the net valence approach, banks should note that enhancing the perceptions of anticipated benefits may offset customers' perceived privacy, financial, and physical risks, thereby increasing their propensity to adopt IRT-based FinTech in ATMs.

Conclusions and future research

FinTech is a relatively recent trend that has evolved as a result of increasing awareness of the advantages of using ground-breaking technologies in the banking and financial industries. FinTech applications based on biometric technologies are pervasive and have been expanding rapidly in these industries. Nevertheless, the rate of customer acceptance and adoption of biometric technologies remains considerably below expectations because biometric technologies in banking are considered a "double-edged sword" by customers, so technologies are regarded as advantageous and unsettling.

In the case of IRT-based FinTech in ATMs, our findings revealed that banks could boost customers' perceptions regarding the technology's financial security by reducing instances of fraud and identity theft, enhancing customer convenience by saving their time and mental efforts, and ensuring safe and hygienic customer experience in a contactless environment. In contrast, our results also demonstrated that the risks of invasion of privacy, physical harm, and financial loss associated with using IRT-based FinTech in ATMs may be too severe for many individuals to accept. Financial institutions, such as banks, may gain the most from such controversial technologies if they focus on maximizing the value and benefits these technologies provide to their

customers and dramatically reducing the risks and concerns those customers perceive. Therefore, it is suggested that banks recognize the importance of incorporating users' security and privacy concerns into biometric policies and provide pertinent information to assuage consumer concerns.

From a positive valence perspective, the present research showed that benefits related to financial security, hygiene, and convenience positively influence the perceived value of using IRT-based FinTech in ATMs. In addition, from a negative valence perspective, the current research demonstrated that perceived value is a direct function of privacy, financial, and physical risk. Furthermore, this study found that the perceived value of IRT-based FinTech in ATMs has a direct positive effect on customers' intention to adopt. Therefore, marketing managers should consider various strategies for increasing users' intentions to use IRT-based FinTech in ATMs. Specifically, marketing strategies targeting potential users should emphasize financial security, hygiene, and convenience values. Additionally, policymakers and practitioners in Jordan must mitigate the perceived risks by implementing policies to minimize risks and secure benefits. From a policy perspective, the government and banks must develop relevant regulations and policies for protecting biometric data to minimize consumers' concerns regarding privacy risks. Moreover, to mitigate financial risk, it is recommended to implement a chargeback policy in Jordanian banks to safeguard IRT consumers against financial fraud or monetary loss. Relevant government entities must further clarify IRT stakeholders' responsibilities and obligations through an improved compliance management system, thereby protecting consumers' rights if financial fraud occurs.

This research has limitations that can be addressed in future investigations. This study identifies Jordan as the cultural context, IRT as the relevant biometric technology, and ATMs as the application of this technology. Given the contextual nature of biometric technologies, it may be difficult to generalize the findings; therefore, we encourage other researchers to replicate this study in various contexts and settings and compare the results to advance our knowledge in this field. In addition, because IRT-based FinTech in ATMs is a new authentication technology that banking customers in Jordan do not widely use, there may be a lack of direct experience with such technology among customers, which may have influenced the study results. Future research could also investigate variations in results between adopters and non-adopters to reflect the effect of direct experience with the technology on its acceptance and adoption. In the context of IRT-based FinTech, potential future research avenues could also investigate the indirect relationships between the benefit and risk dimensions. For instance, it could be examined how Fintech-Enabled Hygiene Benefits can mitigate Physical Risk. Such an investigation could yield valuable insights into the interplay between IRT-based FinTech's benefits and risks. Lastly, future research may incorporate additional essential factors, such as trust and prior experience, into the model proposed in this study and assess their contribution to the increase in explanatory power.

Appendix 1: Constructs and measurement items

Financial security benefit	The security of IRT-based Fintech at ATMs is guaranteed	Lim et al. (2019)
	When I use the IRT-based FinTech at ATMs, the financial transaction process is secure	
	When I use the IRT-based FinTech at ATMs, the user authentication method is secure	
	In using the IRT-based FinTech at ATMs, the financial transaction authentication method is safe	
Convenience benefit	My transaction is going to be completed easily when using IRT-based FinTech at ATMs	Roy et al. (2018); Shankar and Rishi (2020)
	It will not take a long time to complete the authentication process at ATMs using IRT-based FinTech	
	It will not take much cognitive effort to complete the authentication process at ATMs using IRT-based FinTech	
FinTech-enabled hygiene benefit	Using IRT-based Fintech at ATMs protects me from COVID-19 and other contagious diseases	Self-developed
	Using IRT-based Fintech at ATMs safeguards my wellbeing due to its contactless nature	
	Overall, using IRT-based Fintech at ATMs provides me with Hygienic advantages	
Performance risk	The use of IRT-based Fintech at ATMs makes me concerned about whether the function performs as it is supposed to	Stone and Gronhaug (1993); Kleijnen et al. (2007); Byun and Byun (2013)
	The use of IRT-based Fintech at ATMs makes me concerned about how reliable that Fintech is	
	The use of IRT-based Fintech at ATMs makes me concerned about whether that Fintech recognizes my iris consistently over time	
Financial risk	Financial losses are likely when I use IRT-based FinTech at ATMs	Ryu (2018)
	Financial frauds are likely when I use IRT-based FinTech at ATMs	
	Financial losses due to lack of the interoperability with other services are likely when I use IRT-based FinTech at ATMs	
Privacy risk	The use of IRT-based Fintech at ATMs makes me concerned about misuse of my iris scan data by someone else	Wang and Lin (2017); Johnson et al. (2018); Byun and Byun (2013)
	It would be risky to disclose my iris scan information when using IRT-based FinTech at ATMs	
	There would be a high potential for loss in disclosing my iris scan information when using IRT-based FinTech at ATMs	
	I would not feel safe providing personal iris scan information over IRT-based Fintech at ATMs	
Physical risk	I am concerned that the use of IRT-based Fintech at ATMs may pose a health risk	Byun and Byun (2013)
	The usage of IRT-based Fintech at ATMs worries me because of the possible negative consequences it may causes to my wellbeing	
	The usage of IRT-based Fintech at ATMs makes me fearful for my physical safety, as a criminal could harm me by stealing my eye	
Perceived value	Compared to the effort I need to put in, the usage of IRT-based FinTech at ATMs is beneficial to me	Al-Debei et al. (2014)
	Compared to the time I need to spend, the usage of IRT-based Fintech at ATMs is worthwhile to me	
	Taking into consideration the risks associated with the use of IRT-based FinTech at ATMs, its use for banking services is worthwhile to me	
	Overall, the usage of IRT-based FinTech at ATMs delivers me good value	
Adoption intention of IRT-based Fintech at ATMs	I would positively consider IRT-based FinTech at ATMs in my choice set	Cheng et al. (2006); Lee (2009)
	I would prefer IRT-based FinTech at ATMs to authenticate myself	
	I will use IRT-based FinTech at ATMs in the future	

Appendix 2: Factor cross-loadingz

	COB	FIR	HYB	INT	PER	PHR	PRR_	PVA	SEB
COB1	**0.935**	−0.344	0.408	0.301	−0.062	−0.269	−0.379	0.509	0.433
COB2	**0.877**	−0.439	0.433	0.386	−0.057	−0.359	−0.483	0.477	0.372
COB3	**0.948**	−0.363	0.413	0.301	−0.07	−0.283	−0.4	0.523	0.463
FIR1	−0.277	**0.825**	−0.276	−0.323	−0.047	0.528	0.295	−0.351	−0.245
FIR2	−0.431	**0.891**	−0.448	−0.356	0.053	0.299	0.649	−0.546	−0.404
FIR3	−0.351	**0.919**	−0.35	−0.343	−0.001	0.421	0.437	−0.401	−0.323
HYB1	0.422	−0.407	**0.904**	0.439	−0.025	−0.276	−0.498	0.565	0.537
HYB2	0.405	−0.368	**0.902**	0.403	−0.029	−0.219	−0.487	0.555	0.489
HYB3	0.393	−0.358	**0.887**	0.422	−0.027	−0.299	−0.486	0.543	0.509
INT1	0.336	−0.349	0.446	**0.918**	−0.015	−0.384	−0.437	0.49	0.409
INT2	0.317	−0.361	0.425	**0.913**	−0.048	−0.386	−0.391	0.528	0.412
INT3	0.324	−0.357	0.417	**0.912**	0.02	−0.349	−0.443	0.487	0.418
PER1	−0.046	−0.036	−0.023	0.016	**0.899**	−0.139	0.032	−0.038	−0.016
PER2	−0.078	0.053	−0.047	−0.029	**0.94**	−0.052	0.1	−0.071	−0.045
PER3	−0.054	−0.017	−0.003	−0.019	**0.91**	−0.071	0.068	−0.05	−0.029
PHR1	−0.303	0.406	−0.246	−0.351	−0.09	**0.869**	0.35	−0.344	−0.248
PHR2	−0.273	0.37	−0.26	−0.372	−0.064	**0.93**	0.331	−0.384	−0.277
PHR3	−0.318	0.452	−0.293	−0.386	−0.08	**0.919**	0.352	−0.401	−0.325
PRR1	−0.424	0.47	−0.485	−0.414	0.052	0.356	**0.893**	−0.52	−0.454
PRR2	−0.424	0.523	−0.513	−0.441	0.071	0.354	**0.942**	−0.57	−0.477
PRR3	−0.393	0.515	−0.491	−0.405	0.094	0.325	**0.889**	−0.531	−0.445
PVA1	0.531	−0.512	0.561	0.546	−0.066	−0.412	−0.577	**0.883**	0.539
PVA2	0.445	−0.371	0.515	0.434	−0.054	−0.318	−0.476	**0.876**	0.617
PVA3	0.454	-0.452	0.583	0.477	−0.036	−0.357	−0.534	**0.9**	0.607
PVA4	0.52	−0.476	0.547	0.501	−0.064	−0.396	−0.535	**0.917**	0.583
SEB2	0.397	−0.347	0.508	0.434	−0.022	−0.295	−0.45	0.63	**0.901**
SEB3	0.413	−0.318	0.497	0.353	−0.041	−0.251	−0.427	0.595	**0.914**
SEB4	0.416	−0.345	0.524	0.386	−0.045	−0.264	−0.442	0.552	**0.899**
SEB1	0.417	−0.352	0.508	0.437	−0.02	−0.311	−0.485	0.551	**0.852**

Abbreviations

ATM	Automated teller machines
AVE	Average variance extracted
CMB	Common method bias
HTMT	Heterotrait–Monotrait ratio
IRT	Iris recognition technology
IS	Information systems
LM	Linear regression model
NFC	Near-field communication
NVF	Net valence framework
PIN	Personal identification numbers
RMSEA	Root mean squared error
SEM	Structural equation modeling
TAM	Technology acceptance model
UN	United Nations
UNHCR	UN High Commissioner for Refugees
US	United States
VIF	Variance inflation factor

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MD contributes to the acquisition and analysis of the data, in addition to drafting the work, and overall supervision of the conducted research. OH contributes to conception of the work and interpretation of the results. AA contributes to the design of the work methodology, and analysis of the data. All authors read and approved the final manuscript.

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Declarations

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