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Validation and pilot test for items of measurement for adoption of facial recognition payment among senior citizens in Tangshan City of China

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Abstract

This study develops and validates a measurement scale to assess senior citizens' intention to adopt facial recognition payment (FRP) in offline settings in Tangshan, China. Building on the Belief-Attitude-Intention framework and an extended Technology-Organization-Environment-Individual model, the research examines eight key factors: convenience, familiarity, social support, perceived privacy risk, trust, satisfaction, technology anxiety, and intention to use. The study employed a rigorous scale development process involving literature review, expert validation, cognitive interviews, and a pilot test (N=101). The final 34-item questionnaire demonstrated high reliability (Cronbach's α=0.861). The study contributes to the understanding of senior citizens' technology adoption by providing a validated measurement tool and practical insights for designing age-inclusive fintech solutions.

Keywords: Belief-attitude-intention framework, facial recognition payment, measurement scale, senior citizens, technology adoption, Technology-Organization-Environment-Individual model.

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1. Introduction

1.1. Research Background

The global proliferation of contactless payment systems has ushered in a new era of biometric authentication, with facial recognition payment (FRP) emerging as a technologically advanced transaction modality [1]. This innovation, which authenticates users through facial biometrics linked to digital payment platforms, represents a significant evolution in financial technology infrastructure [2]. The integration of artificial intelligence has further enhanced FRP systems, optimizing both transactional efficiency and security protocols [3].

China's financial ecosystem has demonstrated particular receptiveness to FRP adoption, with dominant market players Alipay and WeChat Pay processing approximately 90% of all digital transactions [4]. The technology's implementation trajectory shows remarkable growth since its 2017 pilot phase, achieving market penetration exceeding 495 million users within four years [5]. This rapid adoption has fundamentally transformed China's payment landscape, positioning FRP as a mainstream transaction mechanism across diverse commercial environments.

However, demographic disparities in technology adoption reveal significant challenges. Current data indicate only 12.9% of mobile payment users belong to the over-50 age cohort [6] creating a pronounced digital divide within China's rapidly aging population structure [7]. Empirical observations document systemic exclusion of elderly populations from essential services due to their limited adoption of digital payment systems [8, 9] highlighting critical gaps in financial technology inclusivity.

The selection of Tangshan as a research location is methodologically justified by its representative aging demographics. The population of individuals aged 60 and older is 1,760,635, representing 22.81% of the total population. Among this group, the population of individuals aged 65 and older is 1,232,975, accounting for 15.98% [10]. Moreover, Tangshan represents an intermediate-level digital economic development [11]. This urban context provides an optimal setting for examining senior citizens' acceptance of FRP technology, with findings potentially informing the development of age-inclusive fintech solutions.

1.2. Research Gap

Despite some research about senior citizens' digital financial inclusion in China [12-14] as well as an abundance of research about Chinese facial recognition payment adoption [1, 2, 15-19] there is a need for more studies specific to facial recognition payment in offline settings and a broader demographic. Previous findings have been subject to scrutiny, prompting this study to address the practical and population gap by focusing on senior citizens, specifically those in China who are above 50 years old, and examining their intention to use facial recognition payment services in offline settings. However, existing questionnaires were primarily developed for general populations and may not fully capture the unique factors influencing elderly users' adoption of facial recognition payment. Key limitations include:

First, lack of age-specific measurement scales accounting for social support and technology anxiety among senior citizens. Second, although pilot projects in cities such as Zhengzhou have demonstrated the significant potential of digital payment technologies, their widespread adoption still faces challenges such as inadequate infrastructure and low user acceptance, particularly in third- and fourth-tier cities [20]. Therefore, future efforts should focus on enhanced policy support and technological advancements to facilitate broader diffusion and application. In this process, the collaborative efforts between government and enterprises play a crucial role in driving the development of digital payment technologies. Third, though Chen and Chan [21] explicitly highlighted the moderating role of technology anxiety, there is a lack of research exploring the moderating effect of technology anxiety on senior citizens' intentions toward using facial recognition payment.

Addressing these gaps, this study aims to develop a tailored measurement scale to assess senior citizens' adoption of facial recognition payments.

1.3. Research Objectives

This study aims to develop and validate a measurement scale for assessing senior citizens' intention to use facial recognition payment in offline settings, incorporating key factors such as convenience, familiarity, social support, perceived privacy risk, trust, satisfaction, and technology anxiety. A pretest and a pilot test are conducted to evaluate the reliability and validity of the proposed scale. Furthermore, the study seeks to provide practical recommendations for policymakers and fintech companies to design elderly-friendly payment solutions, ensuring equitable access to digital financial services. By achieving these objectives, this research contributes to both the theoretical advancement and the development of practical strategies for fostering an inclusive digital payment ecosystem.

2. Theoretical Foundations

2.1. Belief-Attitude-Intention (B-A-I) Framework

Fishbein and Ajzen [22] established that individual behavior is systematically shaped through a hierarchical cognitive structure comprising beliefs, attitudes, and behavioral intentions. Beck [23] empirically validated this chain, demonstrating that beliefs predict attitudes, which in turn determine behavioral intentions. Madrigal [24] further elaborated that the B-A-I framework provides a structured model for explaining how individuals form specific behavioral decisions. Within this framework, beliefs are categorized into descriptive (derived from direct observation) and inferential (formed through reasoning) types [22]. Attitudes reflect an individual's affective evaluation of a behavior, encompassing both positive and negative valences [25-27]. Behavioral intention acts as the proximal determinant of actual behavior, representing the subjective likelihood of performing an action [28].

2.2. Technology-Organization-Environment-Individual (TOE-I) Framework

Originally proposed by Tornatzky, et al. [29] the TOE framework analyzes technology adoption through technological, organizational, and environmental dimensions. While widely applied in e-commerce research Oliveira and Martins [30] TOE framework lacks of individual-level factor limits the explanatory power for individual adoption [31]. Thus this study employs an extended TOE-I framework [32] mapping dimensions to elderly-specific adoption factors:

Table 1.
Dimensions of Elderly-Specific Adoption Factors

Dimension	Key Construct	Elderly-Specific Manifestations
Technology	Convenience	The efficiency and ease experienced by senior citizens [32].
Organization	Familiarity	Habitual use of facial recognition-enabled stores [33].
Environment	Social Support	Influence from children/community members [34].
Individual	Perceived Privacy Risk	Concerns about biometric data security [35].

These four dimensions highlight the unique belief factors shaping senior citizens' attitude towards facial recognition payment. Understanding their specific needs—such as the demand for convenience, reliance on familiar merchants, influence from social circles, and heightened privacy concerns—is essential for designing inclusive and effective payment systems tailored to senior citizens.

3. Item Generation and Modification

This study assesses eight variables through the survey, including convenience, familiarity, social support, perceived privacy risk, trust, satisfaction, technology anxiety, and intention to use. These instrument variables were adapted from existing research, and adjustments were made to the survey items to align with the context of offline facial technology payment.

3.1. Convenience

Convenience pertains to the time and effort saved for individuals when they utilize facial recognition payment in offline settings [32]. Hence, the researcher adapted Shiau, et al. [32] six-item convenience scale as the final measurement of convenience in this study.

This is because it has proper levels of reliability (composite reliability:0.85), 6 items' factor loadings range from 0.684 to 0.881, and the average variance extracted (AVE) value, used to assess a construct's convergent validity, is 0.684 [32]. Moreover, the items are already adapted into the facial recognition payment context, it is suitable for this current study. The measurement scale is based on a five-point Likert-scale, whereas: 5 = Strongly Agree; 4 = Agree; 3 = Neither Agree nor Disagree (Neutral); 2 = Disagree; 1 = Strongly Disagree. The items are illustrated in Table 2.

Table 2.
Items Representing Convenience Adapted from Shiau, et al. [32].

No	Original Items	Adapted Items
1	When shopping offline using contactless services, I think it is easy to use FRP.	When shopping using contactless services, I think it is easy to use Facial Recognition Payment (FRP).
2	When shopping offline using contactless services, I find it very convenient to use FRP.	When shopping using contactless services, I find it very convenient to use FRP.
3	When shopping offline using contactless services, I think it is simple to use FRP.	When shopping using contactless services, I think it is simple to use FRP.
4	When shopping offline using contactless services, I think it is more time-saving to use FRP.	When shopping using contactless services, I think it is more time-saving to use FRP.
5	Using FRP in offline contactless services helps me be free of carrying cash, credit cards, and a smartphone everywhere.	Using FRP in contactless services helps me be free of carrying cash, credit cards, and a smartphone everywhere.
6	Using FRP in offline contactless services helps me be free of worrying about taking my smartphone anytime and anywhere.	Using FRP in contactless services helps me be free of worrying about taking my smartphone anytime and anywhere.

3.2. Familiarity

In this study, familiarity pertains to the degree to which customers are familiar with the brick-and-mortar merchants providing facial recognition payment services Pei, et al. [33]. Ouyang, et al. [36] perceived the general familiarity scale reflects individuals' acquaintances with a specific company. Thus, the final measurement of familiarity is adapted from Ouyang, et al. [36] 4-item perceived general familiarity measurement.

The average variance extracted (AVE) scores for all the constructs exceeded the value of 0.50, which varied from 0.703 to 0.938. The values of Cronbach's alpha were all above 0.7, revealing support for constructs' reliability in the research of Ouyang, et al. [36]. The measurement scale is based on a five-point Likert - scale, whereas: 5 = Strongly Agree; 4 = Agree; 3 = Neither Agree nor Disagree (Neutral); 2 = Disagree; 1 = Strongly Disagree. Table 3 displays the items.

Table 3.
Items Representing Familiarity Adapted from Ouyang, et al. [36].

No	Original Items	Adapted Items
1	Regarding [COMPANY1], you are familiar.	For the merchant offering Facial Recognition Payment (FRP), I am familiar.
2	Regarding [COMPANY1], you are experienced.	For the merchant offering FRP, I am experienced.
3	Regarding [COMPANY1], you are knowledgeable.	For the merchant offering FRP, I am knowledgeable.
4	Regarding [COMPANY1], you are informed.	For the merchant offering FRP, I am informed.

3.3. Social Support

In this study, social support includes senior citizens' perception or encounters of care, acknowledgment, respect, acceptance, and social integration, which are supported by the societal network the individual engages with, including family, friends, colleagues, acquaintances, and all other members of the individual's social circle [34]. In the research of Pejić Bach, et al. [34] the social support measure includes activities from the social environment that aim to increase respondents' Internet usage. This study adapted Pejić Bach, et al. [34] 4-item social support measurement as the final measurement.

The composite reliability value of this scale is 0.974. The measurement scale is based on a five-point Likert - scale, whereas: 5 = Strongly Agree; 4 = Agree; 3 = Neither Agree nor Disagree (Neutral); 2 = Disagree; 1 = Strongly Disagree. Table 4 displays the items.

Table 4.
Items Representing Social Support Adapted from Pejić Bach, et al. [34].

No	Original Items	Adapted Items
1	You have someone to help solve Internet-related problems.	I have someone to help solve Facial Recognition Payment (FRP) problems.
2	You have friends or family to provide the necessary help to use the Internet.	I have friends or family to provide the necessary help to use FRP.
3	You have friends and family to help with solving Internet-related problems.	I have friends and family to help with solving FRP problems.
4	You are supported by those around you when you have difficulty using the Internet.	I am supported by those around me when I have difficulty using FRP.

3.4. Perceived Privacy Risk

Perceived privacy risk involves concerns or worries about the possible exposure or compromise of personal information [35]. The Cronbach alpha coefficient for the overall Perceived Privacy Risk was 0.9. Thus, this research adopted Johnson, et al. [35] 5-item perceived privacy risk measurement as the final measurement.

This research removed the reverse-worded question from the original questionnaire because the research of Sonderen, et al. [37] suggests that such items do not effectively prevent response bias. Instead, as stated, "We did not find evidence that ten reverse-worded items prevented response bias. Instead, the data suggest scores were contaminated by respondent inattention and confusion." This indicates that reverse-worded items may introduce unintended measurement errors due to respondent confusion or lack of attention, ultimately compromising data quality rather than enhancing it. Therefore, to ensure clarity and reliability in responses, the reverse item from the questionnaire is excluded from the questionnaire.

This research chose Johnson, et al. [35] perceived privacy risk measurement due to its adequate reliability levels (composite reliability: 0.93), with factor loadings for four items ranging from 0.80 to 0.92, and an average variance extracted (AVE) value of 0.77, which is utilized to evaluate a construct's convergent validity [35]. The measurement scale is based on a five-point Likert - scale, whereas: 5 = Strongly Agree; 4 = Agree; 3 = Neither Agree nor Disagree (Neutral); 2 = Disagree; 1 = Strongly Disagree. The items of perceived privacy risk are shown in Table 5.

Table 5.
Items Representing Perceived Privacy Risk Adapted from Johnson, et al. [35].

No	Original Items	Adapted Items
1	I would not feel safe providing personal private information over mobile payment services.	I would not feel safe providing personal private information over Facial Recognition Payment (FRP).
2	I am worried about other people gaining access to my account if I use mobile payment services.	I am worried about other people gaining access to my account if I use FRP.
3	I would not feel secure sending sensitive information across mobile payment services.	I feel insecure sending sensitive information across FRP.
4	Using mobile payment systems would involve more financial risk when compared to traditional ways of shopping.	Using FRP would involve more financial risk when compared to traditional ways of shopping.
5	I don't think there is any real financial risk associated with mobile payment systems (reverse question).	

3.5. Trust and Satisfaction

Jones [38] stated that trust is an attitudinal response that applies to the relationship between an individual and an object. Helm [39] viewed trust as a reactive attitude that typically arises based on the individual's knowledge and beliefs subsequent to a particular event. While Meyer and Schwager [40] characterized satisfaction as the outcome of consumer interactions, where it emerges from the balance between expectations and experiences [41]. Satisfaction can manifest at two phases: before adoption (pre-adoption satisfaction) and after adoption (post-adoption satisfaction) of a product or service [42]. Various factors, including customer preferences, expectations, and prior encounters, influence satisfaction at each stage. Satisfaction depends on how large and in which direction the difference lies between what a person expects and how they actually perceive the performance—whether it exceeds or falls short of expectations [43]. Both trust and satisfaction measurements are adapted from Shiau, et al. [32] since this study already tested trust and satisfaction measurements in the offline facial recognition payment scenarios, limited only to younger populations.

In the research of Shiau, et al. [32] the composite reliability value of the measurement of "Trust" is 0.891, the factor loadings are 0.624 - 0.916, and the AVE value is 0.676.

In terms of "Satisfaction", the factor loadings are between 0.888 and 0.913, the AVE value is 0.813, and with a proper level of composite reliability at 0.946. The measurement scale is based on a five-point Likert - scale, whereas: 5 = Strongly Agree; 4 = Agree; 3 = Neither Agree nor Disagree (Neutral); 2 = Disagree; 1 = Strongly Disagree. Tables 6 and 7 show the items.

Table 6.
Items Representing Trust Adapted from Shiau, et al. [32].

No	Original Items	Adapted Items
1	I have confidence in using FRP in offline contactless services.	I have confidence in using Facial Recognition Payment (FRP) in contactless services.
2	I have no reservations about using FRP in offline contactless services.	I am comfortable using FRP in contactless services.
3	Using FRP in offline contactless services is trustworthy.	Using FRP in contactless services is trustworthy.
4	I can rely on using FRP in offline contactless services.	I can rely on using FRP in contactless services.

Table 7.
Items Representing Satisfaction Adapted from Shiau, et al. [32].

No	Original Items	Adapted Items
1	I am delighted to use FRP in offline contactless services.	I am delighted to use Facial Recognition Payment (FRP) in contactless services.
2	Using FRP in offline contactless services makes me feel happy.	Using FRP in contactless services makes me feel happy.
3	My choice to use FRP in offline contactless services is a wise one.	My choice to use FRP in contactless services is a wise one.
4	I think that I do the right thing in using FRP in offline contactless services.	I think that I do the right thing in using FRP in contactless services.

3.6. Technology Anxiety

In this current work, technology anxiety refers to an individual's feelings of apprehension or fear when confronted with the prospect of using technologies [44]. Similar to self-efficacy, technology anxiety pertains to users' overall perceptions regarding the use of technology [45]. The researcher selected Hoque and Sorwar [46] 4-item Technology Anxiety measurement as the final measurement of technology.

This can be attributed to its sufficient composite reliability: 0.8990, where the factor loadings of four items span from 0.8118 to 0.8383, along with an average variance extracted (AVE) value of 0.6899, and this measurement's Cronbach's alpha value is 0.8506. The measurement scale is based on a five-point Likert - scale, whereas: 5 = Strongly Agree; 4 = Agree; 3 = Neither Agree nor Disagree (Neutral); 2 = Disagree; 1 = Strongly Disagree. The items are illustrated in Table 8.

Table 8.
Items Representing Technology Anxiety Adapted from Hoque and Sorwar [46].

No	Original Items	Adapted Items
1	Using mHealth services would make me very nervous.	Using Facial Recognition Payment (FRP) would make me very nervous.
2	Using mHealth services makes me worried.	Using FRP makes me worried.
3	Using mHealth services may make me feel uncomfortable.	Using FRP may make me feel uncomfortable.
4	Using mHealth services may make me feel uneasy and confused.	Using FRP may make me feel uneasy and confused.

3.7. Intention to Use

Intention to use is defined as customers' intend to use a technology in the present or future Ahn, et al. [47]. Davis [48] discovered that there is a significant correlation between the intention to use a particular system and actual usage. Moreover,

he highlighted that behavioral intention plays a pivotal role in determining user behavior, while other factors exert their influence on user behavior indirectly through affecting behavioral intention. This study adopts a five-item reflective construct's intention to use scale from De Luna, et al. [49] to measure intention to use facial recognition payment.

The composite reliability value of "Intention to use" in the research of De Luna, et al. [49] is 0.94. The measurement scale is based on a five-point Likert - scale, whereas: 5 = Strongly Agree; 4 = Agree; 3 = Neither Agree nor Disagree (Neutral); 2 = Disagree; 1 = Strongly Disagree. Table 9 shows the items.

Table 9.
Items Representing Intention to Use Adapted from De Luna, et al. [49].

No	Original Items	Adapted Items
1	Given the opportunity, I will use a mobile SMS/NFC/QR payment system.	Given the opportunity, I will use Facial Recognition Payment (FRP).
2	I am likely to use a SMS/NFC/QR payment system in the near future.	I am likely to use FRP in the near future.
3	I am open to using an SMS/NFC/QR mobile payment system in the near future.	I am open to using FRP in the near future.
4	I intend to use an SMS/NFC/QR mobile payment system when the opportunity arises.	I intend to use FRP when the opportunity arises.

3.8. Finalizing Measurement of the Study

There are a total of eight variables in the current study. Intention to use is the dependent variable. Convenience, Familiarity, Social Support, and Perceived Privacy Risk are independent variables. Trust and Satisfaction are both independent variables and dependent variables. Technology Anxiety serves as a moderator between the relationship of attitude (trust, satisfaction) and intention to use. Generally, there is a total of 34 items in the questionnaire. Table 10 illustrates the details of the construct's measurement and measurement sources.

Table 10.
Constructs Measurements and Measurement Sources.

Variables	Measurement	Sources	No of Items
Convenience	Convenience	Shiau, et al. [32]	6
Familiarity	Familiarity	Ouyang, et al. [36]	4
Social Support	Social Support	Pejić Bach, et al. [34]	4
Perceived Privacy Risk	Perceived Privacy Risk	Johnson, et al. [35]	4
Trust	Trust	Shiau, et al. [32]	4
Satisfaction	Satisfaction	Shiau, et al. [32]	4
Technology Anxiety	Technology Anxiety	Hoque and Sorwar [46]	4
Intention to Use	Intention to Use	De Luna, et al. [49]	4

3.9. Back Translation

Since English is not an official language in China, the questionnaire that was originally written in English was translated into Chinese using the back-translation method suggested by Brislin [50]. Four experienced translators from the College of Foreign Languages at North China University of Science and Technology (NCST) were responsible for the consecutive translation. The process involved the subsequent stages: The process involves four steps: (1) The questionnaire is translated from English to Chinese by an expert; (2) The translation is then reviewed by another expert; (3) The Chinese questionnaire is retranslated back to English by another expert; (4) Finally, the retranslated version is reviewed by other expert. The back translation results from Chinese to English were compared with the original English version to verify the content's accuracy, following these steps, as a result, the questionnaire was produced in both English and Chinese languages.

4. Pretest and Pilot Test

To ensure the robustness of the measurement instrument, a two-phase validation process was implemented: pretest (focusing on qualitative validity checks) and pilot test (quantitative reliability assessment).

4.1 Pretest: Validity Assessment

The pretest focused on optimizing the questionnaire's design through two complementary approaches. First, expert validation was performed by a panel of three specialists (one from University Utara Malaysia and two from North China University of Science and Technology), who evaluated the instrument's structural coherence, including item wording, logical sequencing, and cultural appropriateness [51]. Second, cognitive interviews were conducted with 15 FRP senior citizen users in Tangshan City to identify ambiguities arising from cross-cultural translation [52]. Participants engaged in concurrent think-aloud protocols [53] (e.g., "How would you explain this term to a friend?") and retrospective debriefings (e.g., "What did you assume this question meant?"), following Drennan [54]'s methodology. This iterative process led to revisions in 9% of items, such as simplifying technical jargon and clarifying context-dependent phrases [55]. Table 11 shows the revisions.

Table 11.
Revisions to Measurement Instrument Following Cognitive Interviews.

Original Item (Pre-Test)	Revised Item (Post-Test)	Type of Revision	Rationale
When shopping using contactless services, I think it is easy to use Facial Recognition Payment (FRP).	When shopping using contactless services, it is easy to use Facial Recognition Payment (FRP).	Simplified sentence structure	Some senior citizens interpreted "I think" as "I need to guess the answer", leading to hesitant responses.
I have friends or family to provide the necessary help to use FRP.	I have friends or family to teach me to use FRP.	Operationalization & Specificity	"Teach" is more behaviorally specific than "provide help", easy to understand by senior citizens.
Using FRP would involve more financial risk when compared to traditional ways of shopping.	Using FRP makes it easier to lose money compared to traditional shopping methods.	Conceptual Operationalization	-Chinese elderly particularly fear direct money loss. -"Easier to" frames comparison more intuitively than abstract "more risk".

4.2. Pilot Test: Reliability Assessment

After confirming the validity of the questionnaire, the researcher then evaluated the internal reliability of the improved instrument utilized in this study. Reliability, according to Kothari [51] refers to the degree of accuracy and precision exhibited by a measuring process. In order to assess this, the inter-item consistency of all characteristics being examined was carefully examined. The instrument's reliability was evaluated using Cronbach's Alpha coefficient, which is considered outstanding if it surpasses 0.90, good if it is about 0.80, acceptable if it is around 0.70, and dubious if it is about 0.60. Values that fall below 0.60 are considered unsatisfactory and of low quality [56].

Hence, a total of 101 responses were collected from the participants to evaluate the internal consistency of the refined questionnaire. Using SPSS 27, the measurements of all constructs were analyzed. Table 12 presents a summary of the reliability outcomes, demonstrating satisfactory internal consistency for all constructs examined.

Table 12.
Constructs' Cronbach's Alpha Values.

Construct	No of Items	Cronbach's Alpha
Convenience	6	0.908
Familiarity	4	0.903
Social Support	4	0.907
Perceived Privacy Risk	4	0.887
Trust	4	0.903
Satisfaction	4	0.901
Technology Anxiety	4	0.945
Intention to Use	4	0.940
Overall	34	0.861

5. Data Collection: Adapted Survey Methodology for Senior Citizens

The survey questionnaire serves as an effective method for quantitative business research, particularly when collecting large amounts of data efficiently and at minimal cost [57]. Given these advantages, this study employed a self-administered**,** paper-based survey to gather responses from senior citizens in Tangshan, China. This approach was carefully selected to align with the unique needs and characteristics of senior citizen respondents, ensuring both accessibility and reliability in data collection.

Each survey package included a printed questionnaire, designed with enlarged font sizes and clear formatting to accommodate potential vision impairments common among older adults [58]. Accompanying the questionnaire was an introductory letter, which outlined the study's purpose, assured participants of confidentiality and anonymity, and requested approximately 15–30 minutes of their time. The letter concluded with an expression of gratitude for their participation, emphasizing the value of their input.

A paper-based format was chosen over digital alternatives due to several considerations specific to senior citizens respondents. First, many seniors experience vision difficulties, making printed materials easier to read and process compared to digital screens [59]. Second, older adults may be less familiar with online surveys, leading to potential barriers in participation. By using face-to-face distribution, researchers could personally explain the survey, answer questions, and encourage completion—a method proven to enhance response rates among elderly populations [60]. This hands-on approach not only improved accessibility but also ensured that the data collected reflected the true perspectives of senior citizens in Tangshan.

The decision to distribute questionnaires manually further supported the study's goal of obtaining high-quality responses. Structured items were administered in person, allowing researchers to provide immediate assistance if needed. This method, recommended by Parker [61] and Rowley [58] proved particularly effective in engaging elderly participants, who often

appreciate direct interaction and clarity in survey instructions. By prioritizing these adaptations, the study aimed to maximize both participation and accuracy in measuring senior citizens' attitudes toward facial recognition payment adoption.

6. Conclusion

This study has developed and validated a comprehensive measurement scale to assess senior citizens' intention to adopt facial recognition payment systems in Tangshan, China. Through a rigorous process that included literature review, expert validation, cognitive interviews, and pilot testing, this research established a reliable 34-item questionnaire with strong psychometric properties. The findings underscore the critical importance of adapting technology adoption models to account for the unique needs and characteristics of senior citizens, particularly in terms of interface design, privacy concerns, and social support systems. The research highlights how traditional barriers to technology adoption manifest differently among senior citizens, with factors like technology anxiety and perceived privacy risk playing more prominent roles than in younger demographics. The validation process revealed that careful attention to questionnaire design, including language simplicity, visual clarity, and administration method, significantly impacts data quality when working with elderly respondents. These insights contribute valuable knowledge to both academic research on technology adoption and practical applications in fintech development. While the study focused specifically on Tangshan's senior population, the methodology and findings offer transferable lessons for understanding elderly technology adoption patterns in similar urban contexts across China. Future work should build on these findings to develop more inclusive financial technologies that accommodate the diverse needs of all age groups in society.

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Appendix 1

Convenience	CON1. When shopping using contactless services, it is easy to use Facial Recognition Payment (FRP).
	CON2. When shopping using contactless services, I find it very convenient to use FRP.
	CON3. When shopping using contactless services, it is simple to use FRP.
	CON4. When shopping using contactless services, it is more time-saving to use FRP.
	CON5. Using FRP in contactless services helps me free of carrying cash, a credit card and a smartphone everywhere.
	CON6. Using FRP in contactless services helps me free of worrying about taking my smartphone anytime and anywhere.
Familiarity	FAM1. For the merchant offering Facial Recognition Payment (FRP), I am familiar.
	FAM2. For the merchant offering FRP, I am experienced.
	FAM3. For the merchant offering FRP, I am knowledgeable.
	FAM4. For the merchant offering FRP, I am informed.
Social Support	SS1. I have someone to help solve Facial Recognition Payment (FRP) problems.
	SS2. I have friends or family to teach me to use FRP.
	SS3. I have friends and family to help with solving FRP problems.
	SS4. I am supported by those around me when I have difficulty using FRP.
Perceived Privacy Risk	PPR1. I would not feel safe providing personal private information over Facial Recognition Payment (FRP).
	PPR2. I am worried about other people gaining access to my account if I use FRP.
	PPR3. I feel insecure sending sensitive information across FRP.
	PPR4. Using FRP makes it easier to lose money when compared to traditional shopping methods.
Trust	TRU1. I have confidence in using Facial Recognition Payment (FRP) in contactless services.
	TRU2. I am comfortable using FRP in contactless services.
	TRU3. Using FRP in contactless services is trustworthy.
	TRU4. I can rely on using FRP in contactless services.
Satisfaction	SAT1. I am delighted to use Facial Recognition Payment (FRP) in contactless services.
	SAT2. Using FRP in contactless services makes me feel happy.
	SAT3. My choice to use FRP in contactless services is a wise one.
	SAT4. I think that I am doing the right thing in using FRP in contactless services.
Technology Anxiety	TA1. Using Facial Recognition Payment (FRP) would make me very nervous.
	TA2. Using FRP makes me worried.
	TA3. Using FRP may make me feel uncomfortable.
	TA4. Using FRP may make me feel uneasy and confused.
Intention to Use	INT1. Given the opportunity, I will use Facial Recognition Payment (FRP).
	INT2. I am likely to use FRP in the near future.
	INT3. I am open to using FRP in the near future.
	INT4. I intend to use FRP when the opportunity arises.