"I Have to Use My Son's QR Code to Run the Business": Unpacking Senior Street Vendors' Challenges in Mobile Money Collection in China

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Mobile payment systems have become an infrastructural component in citizens' socio-economic life in China. The rapid shift to a cashless society demands vendors of all ages to quickly adapt themselves to the ubiquitous mobile payment era. However, how this trend may impact senior vendors, a group that typically uses less technology, remains unknown despite its significance in inclusive mobile payment design. This work aims to address this gap by investigating the challenges and strategies of senior vendors in mobile payment adoption. Particularly, we focus on a traditional low-resource setting with a large volume of senior vendors: street vending. We conduct a qualitative study incorporating field observations on 33 senior street vendors and semi-structured interviews with 15 of them (aged 53-78), and take Moneywork as an analytical lens to unpack their challenges in physical and social interactions. We find that senior street vendors are a group passively adopting mobile payments due to business requirements instead of recognizing their advantages. Vendors with relatively low digital literacy have to take an alternative method - using family members' QR codes - to run the business as family-dependent money receivers. With limited considerations for senior vendors' situational vulnerabilities, unexpected difficulties of payment confirmation emerge during transactions, such as reduced confirmation efficacy under noisy surroundings and degraded hearing. Transaction security issues also appear when mobile payment-based frauds target both confirmation interfaces (e.g., fake sounds of successful payment) and trust systems (e.g., showing half-done proof to flee without paying) in street vending. Finally, we raise a less visible yet critical concern of family-dependent vendors on the lost money freedom when their income flows into their families' wallets. We propose design implications for mobile payment systems to support more secure, efficient and accessible money collection services to underrepresented groups.

CCS Concepts: • **Human-centered computing** → **Accessibility**.

Additional Key Words and Phrases: mobile payment; older adults; senior street vendors; digital inclusion; HCI4D

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1 INTRODUCTION

Mobile payment systems are increasingly penetrating the socioeconomic life of people living in the
Global South [2, 3, 68, 84, 97]. In particular, mobile payment systems in China, with representative
applications such as Alipay and WeChat Pay, have been an infrastructural element across physical,
social, and digital ubiquity [30, 84]. By the end of 2020, the number of mobile payment users in China
has reached 854 million, the market of which has exceeded 400 trillion yuan [22]. The ubiquitous
mobile payments not only bring benefits and conveniences, but also raise substantial challenges to
marginalized and underrepresented populations, who need to change vastly in financial behaviors
and perceptions [84]. Such impacted groups include less tech-savvy older adults, who are threatened
to be left behind by the cashless economy [61, 74]. Understanding how older adults adapt themselves
to the "mobile payment era" [30], and what challenges they experience, is of great significance for
designing a more inclusive and accessible mobile payment ecosystem.

A burgeoning body of research in HCI and CSCW has begun to explore mobile payment systems
from the HCI4D perspective, uncovering how individuals in the Global South may encounter
challenges in adopting mobile payments (e.g., [13, 31, 34, 50, 70, 80]). In particular, some researchers
focused on factors influencing older adults' acceptance of mobile payments such as perceived ease
of use [32], perceived usefulness [32] and perceived risks [32, 75, 104, 107], and came up with
strategies for inclusion and promotion (e.g., money gamification [104]). However, most previous
works investigated older adults' experiences of mobile payments as customers, yet few centered on
another group of key stakeholders in the business ecosystem, i.e., senior vendors. Compared to
senior customers who can still choose cash in most scenarios and thus have a smoother transition
to the cashless society, senior vendors face a sharper change to the ubiquity of mobile payments
for everyday business. Besides, vendors confront naturally distinct transaction-related challenges
compared to customers, such as novel mobile payment-based frauds and alteration of the payment
confirmation process. In this work, we aim to address this gap by investigating how senior vendors
adopt mobile payments for money collection and the challenges in this process, which shed light
on implications for efficient, secure, and accessible mobile payment systems before moving into a
cashless society.

We situate this work in the setting of street vending, i.e., how **senior street vendors** adapt
themselves to using mobile payments for money collection. Street vendors offer goods or services for
sale to the public with only a temporary static structure or mobile stall [67]. We choose this setting
because: (1) The transactions happen under uncertain and complex surroundings (e.g., poor network
and light) [9, 25, 33], which might bring unexpected challenges and thus raise a higher demand for
mobile payments design; (2) The street setting limits the simpler and faster vendor-initiated money
collection using electronic cash registers that are functional yet less mobile [16], putting senior
vendors at a passive and vulnerable situation relying on customer-initiated QR code scanning; (3)
Street vending is a popular type of informal economy across the Global South [36, 59, 67], and
some considerations of mobile payment design may be valuable to other countries in the Global
South. Specifically, we propose the following research questions:

- **RQ1**: What are the challenges of senior street vendors in adopting mobile payments for
  money collection?
- **RQ2**: What strategies do senior street vendors use to adapt themselves to the cashless
  economy?

As mobile payment transactions are highly embedded in a physical and social world, a significant body of work has underscored the importance of understanding transactional interactions in specific contexts, instead of only focusing on the transfer of value [6, 24, 52, 76]. Thus, to comprehensively investigate senior street vendors' situational challenges and strategies in mobile payment adoption, we leverage Perry and Ferreira's theoretical framework "Moneywork" [76] as an analytical lens in this study. Moneywork suggests considering "*physical and social interactions that users make individually and collectively in order to enable transactions*" [52, 76], and underscores how social and interactional aspects of monetary transactions are processual, interdependent, and highly situated. It proposes three distinct phases for transactional interactions including (1) pre-transaction, (2) at-transaction, and (3) post-transaction work to complete a financial transaction. Moneywork has proven effective to uncover additional labor, challenges, and vulnerabilities for underrepresented groups' transactional interactions [6, 38, 42, 43], and is well applicable to our context.

To answer the research questions, we designed a qualitative study incorporating field observations on 33 senior street vendors (aged 53-72) and semi-structured interviews with 15 of them. We found that senior street vendors were largely market-driven to use mobile payments instead of recognizing their conveniences, and typically set up mobile payments under family support. Some less tech-savvy senior street vendors even became totally family-dependent to run their everyday business (e.g., using family's QR codes). Due to the vulnerabilities of seniors and the complexity of street settings, unexpected difficulties in payment confirmation mechanisms emerged, such as reduced efficacy in noisy surroundings. Besides, senior vendors were troubled by mobile payment-based frauds that targeted confirmation interfaces (e.g., fake sound signals of payment) or trust systems (e.g., invalid half-done proof). The lost money freedom, when income flowed into the family's wallet, also brought difficulties and concerns to family-dependent vendors, such as the exposed business privacy to family members. Based on the findings, we discuss three key considerations including (1) understanding contextual vulnerabilities of underrepresented groups, (2) family as a cushion against technology impact in China, and (3) the heterogeneity in HCI4D and support for non-users.

In conclusion, this work makes the following contributions to HCI and CSCW: (1) unpacking the challenges of senior street vendors facing the ubiquity of mobile payment, and emphasizing the understanding of contextual vulnerabilities of underrepresented groups in different transactional stages; (2) revealing the varied strategies of senior street vendors to conduct mobile money collection, and necessitating considerations for heterogeneity in HCI4D and support for non-users; (3) discovering how family serves as a cushion for older adults against the rapid shift to a cashless society in China, and raising implications for family-friendly design in response to the technology impact. This work expands existing knowledge of mobile payment systems in China, and brings new insights into accessible and senior-friendly mobile payment design.

2 BACKGROUND

This section describes two important aspects of socioeconomic and sociocultural background that this work is situated in: *the ubiquity and homogeneity of mobile payments* and *senior street vendors* in China.

2.1 Ubiquity and Homogeneity of Mobile Payments in China

The digital payment systems in China are broadly different from other countries [84]. In this section, we demonstrate two basic features of mobile payments in China - ubiquity and homogeneity, which help readers better contextualize this study.

First, with the rapid increase in smartphone and Internet penetration, mobile payments in China become ubiquitous. Based on the People's Bank of China, 89.16% adults used digital payments

in 2020 [66]. Around 83% of all payments were made via mobile payment modes in 2018, the penetration of which was largely higher than in other Asian countries such as India, Japan and South Korea [16]. Previous work [84] found mobile payments were ubiquitously used in different physical (e.g., offline shopping and dining), digital (e.g., online shopping), and social activities (e.g., red packets [105]) in Chinese life.

Second, mobile payments in China are relatively homogeneous. For service providers, WeChat Pay and Alipay are two dominant mobile payment services, both of which are used by more than 90% mobile payment users [16, 73]. For the payment approach, scanning the QR code is used by more than 95% mobile payment users [73], when other payment methods such as near-field communication (NFC) [77] are less adopted. The Chinese government has also enforced policies to support the use of individuals' QR codes for micro business in addition to business accounts [1]. As such, in the low-resource setting of street vending, providing (WeChat Pay and Alipay) QR codes for customers to scan and pay becomes the *de facto* solution for senior vendors to collect digital money.

2.2 Senior Street Vendors in China

In this work, we follow the definition of street vendors as "*a person who offers goods or services for sale to the public without having a permanently built structure but with a temporary static structure or mobile stall*" [67]. Because of no need to pay rent, street vending has a relatively low barrier in cost, and typically offers a job opportunity to people with low literacy or disability [25]. However, debates are also raised especially on concerns about noise, pollution and congestion, which leads to changing policies in China [33]. For example, after the outbreak of COVID-19, "stall economy" was proposed as a measure to revive the economy and reduce unemployment in China with less strict street vending policies, though it did not last for a long time [86]. As an important component in the real economy yet with controversial opinions, street vendors in China have been widely investigated in urban governance [8, 33], urban design [91] and urban economics [106].

However, little work has been put on the technology use among street vendors, especially the senior groups above 50 [2]. Senior street vendors account for a large proportion of this traditional career [9, 36], yet are vulnerable under the rapid technology revolution [61]. The shift to a cashless economy brings one of the most substantial changes to senior street vendors' everyday routines. The scenario of street vending adds some additional challenges to the adoption of mobile payment. First, transactions happen in mobile stalls, making it difficult to adopt functional yet less mobile electronic cash registers for money collection similar to physical stores, i.e., cashiers scanning customers' QR codes, which is simpler and faster [16]. Though FinTech companies in China have proposed more portable and independent QR-code scanners, the need to purchase, configure, and learn to use the external device, and the inconveniences of manually inputting amounts during the busy business, limit such vendor-initiated QR-code scanners to be adopted by street vendors. Second, the surroundings of street vending are uncertain and complex (e.g., poor network connections and light) [9, 25, 33], which might bring unexpected difficulties. Third, senior street vendors need to simultaneously take multiple tasks on business (e.g., preparing goods, calculating price and keeping away from urban management officers) [8, 33, 86], which limits the time and effort in money collection and validation. This work aims to explore how senior street vendors, who are seen as a vulnerable and less tech-savvy group, adapt themselves to the cashless society and cope with challenges in the complex setting of street vending.

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[1]http://www.gov.cn/zhengce/2022-02/25/content_5675557.htm
[2]In this work, we use "seniors" to refer to people above 50, the earliest retirement age in China.

3 RELATED WORK

3.1 Mobile Payments and HCI4D

Mobile payment systems in the Global South, as a significant component in financial inclusion [78], have been an important topic in HCI4D research. Some early work focused on the facilitating conditions, adoption, and usability of mobile payments in the Global South such as Uganda, India and Kenya [26, 57, 64, 71]. Challenges for mobile payments in the Global South, especially those concerning individual customers' use, were further identified, such as distrust [13], security problems [70, 80], privacy concerns [34] and constraints of financial literacy [50]. In addition to *customers*, two other groups of stakeholders' efforts and challenges also attracted researchers' attention, including *agents*, who were fundamental in assisting with adoption and improving financial literacy in low resource contexts [40, 42, 88]; and *vendors*, who were required to have additional effort to adapt to the mobile payment-based money collection [42, 97]. Recently, researchers also highlighted the nonnegligible threat of mobile-based frauds in the Global South such as India [42] and Pakistan [79].

In particular, supporting vulnerable groups with special difficulties and requirements has become one of the key considerations of the HCI4D perspective in mobile payments. Kameswaran and Muralidhar found that both cash and digital payments were inaccessible to people with visual impairments in India, and they had to conduct added work to overcome the inaccessibility before, at and after transactions [43]. Chauhan discussed how to support below-poverty-line citizens in India on mobile-money acceptance, and highlighted the significance of trust in the adoption process [13]. Another study by Jain et al. revealed the vulnerability of low-income Indian merchants confronting mobile payment-targeted frauds, including fraud via fake payment confirmation and fraud via fake QR code stickers [42].

To comprehend challenges and vulnerabilities of marginalized groups in adopting digital payments, a growing body in HCI and CSCW has adopted Moneywork [76] to frame their physical and social interactions in transactions [6, 38, 42, 43]. Moneywork was initially defined in the anthropological literature as the physical work of managing everyday financial tasks [14]. HCI researchers have expanded the notion of Moneywork as "*the physical and social interactions that users make individually and collectively in order to enable transactions*" [52, 76]. The Moneywork framework largely echoes the trend of considering digital money from the perspective of "transactions" to "interactions" [24], and has been applied to broad scenarios in financial inclusion and accessibility, such as financial management [7] and third-party financial access [6]. Following this strand of work, we leverage Moneywork as an analytical lens to organize and understand situational challenges of senior street vendors in mobile money collection.

This work contributes to the research venue on mobile payments and HCI4D by uncovering how senior street vendors in China adopt mobile payment, and what challenges they encounter. Different from prior work, the scenario of street vending [33, 86] is featured by: (1) limited time in payment confirmation; (2) uncertain and undesirable surroundings. However, though the setting is highly complex, many vendors in this traditional profession are in old age and with low (digital) literacy [36, 84], some of whom even do not have mobile phones but have to accept customers' mobile payments. Understanding this group's adaptation to the mobile payment era and relevant challenges would shed light on implications for more inclusive mobile payment systems in the Global South.

3.2 Mobile Payments and Older Adults

Age has been regarded as a significant factor that influences people's perceptions of technology [19, 95]. Among different age groups, older adults tend to lag in adopting new technologies and remain

on the disadvantaged side of the digital divide [5, 96, 109], and a previous study in Malaysia found that older adults had more challenges in adopting mobile devices [58]. The reasons are dynamic and nuanced. Cognitive, motor and sensory decline with aging is an important factor [81] but can not apply to all scenarios [100]. Actually, works in different contexts propose that negative attitudes due to fear, distrust, anxiety, and a lack of motivation and interest, are the dominant explanation for older adults' technology non-use [35, 46, 46, 98]. As such, taking a more holistic view of designing for older adults, away from stereotypes, is a growing trend in the HCI and CSCW community [82, 99].

With the increasingly essential role of mobile payments in people's socioeconomic life, older adults' use of mobile payments has also been a topic of concern. Fewer than one in five (17%) adults aged 65 or older in the United States used mobile payments services, the proportion of which was much lower than younger adults (more than 70%) [4]. In China, older adults above 60 also had a much lower adoption rate of mobile payments (~50%) [74] compared to the general public (~90%) [66]. To this end, a line of research focused on why and how older adults adopted (and did not adopt) mobile payments, and how to promote their adoption. For example, Hanafi and Toolib revealed that perceived ease of use, perceived usefulness and perceived security all influenced older adults' intention to adopt e-payment in Malaysia [32]. Among them, the perceived security (and risks) was substantially influential [32, 75, 104, 107]. Younger family members played a significant role in mobile payment's introduction and instruction for older adults [18, 68, 97]. Gamification was proved to be effective in supporting older adults' mobile payment use in China [104].

However, there is still a dearth of research on the challenges of senior vendors, as money receivers, in adapting to the cashless society and adopting mobile payments. Specifically, different from senior customers who still have the choice of cash payment in most scenarios, vendors are more like a group that is "forced" to follow the trend of mobile payments, when customers increasingly do not take cash. Also, they need to accommodate new tasks (e.g., digital payment confirmation) and might face unexpected problems (e.g., frauds targeting mobile payments) in the mobile payment settings. As such, this work aims to understand situational challenges of senior street vendors in using mobile payments, which not only enriches the understanding of seniors' mobile payment adoption, but also yields implications for more secure, convenient and senior-friendly mobile payment systems.

3.3 Mobile Payments in China

As a market with nearly a billion users and more than 400-trillion-yuan transactions [22], mobile payments in China have gained increasing attention. As noted by Shen et al., mobile payment systems have been regarded as an infrastructural element in Chinese social life [84]. From a macroscopic perspective, scholars have investigated the political, social, economic, and regulatory aspects of this huge mobile payment ecosystem [29, 54, 102].

Recently, HCI and CSCW researchers have begun to look at the microscopic perspective of mobile payments in China, i.e., how this system shaped end-users' experiences. For example, Kow et al. raised the conceptual frame "*special digital monies*" and highlighted the flexibility of digital money (e.g., allowing users to define the transactional rules) could vastly support users beyond standard retail contexts in China [47]. Shen et al. uncovered the physical, digital and social ubiquity of mobile payments to end-users, illustrating that mobile payments had penetrated into every corner of life in China [84]. How mobile payments were integrated into Chinese cultural practice also drew researchers' interest. For instance, Wu and Ma investigated *red packet gifting* in the Chinese online community to reveal money as a social currency to manage group dynamics [105].

Unfortunately, the rapid development of mobile payments inevitably raises challenges for marginalized and underrepresented groups with unique vulnerabilities. Previous work has indicated the difficulty that the ubiquitous mobile payments in China brought to less tech-savvy people [84]. Nonetheless, though researchers have focused on the HCI4D perspective of mobile payments in other countries in the Global South (e.g., [26, 42, 97]), little relevant work looked at the setting of China, where the ubiquity and homogeneity of mobile payments are required to be considered for vulnerable groups. This work aims to address this gap by investigating senior street vendors' challenges and strategies in mobile money collection.

4 METHOD

We conducted a qualitative field study to investigate senior street vendors' challenges and strategies in using mobile payments for money collection. We first started our study with observations of 33 senior street vendors, focusing on their transactional interaction with consumers without the interventions of researchers. Then, we interviewed 15 senior street vendors (age: 53-78) to uncover their situational challenges and strategies in depth. The whole recruitment and study procedure was approved by the institutional review board (IRB).

4.1 Participant Recruitment

To diversify participants' demographic information, we conducted the fieldwork in Guangdong, one of the provinces that have highly unbalanced regional development in China [103], and recruited senior street vendors from country, town to city. As a study focusing on mobile payment use of senior street vendors, the eligible participants should be above 50 years old (the earliest retirement age in China), and adopt any of the mobile money collection approaches for at least three months to have a basic understanding of them. To cover vendors with different digital literacy, we did not exclude any mobile payment adoption patterns, even in the most elementary way. For example, senior street vendors who had not used mobile phones but provided printed QR codes of family members' or friends' accounts were also included in this study.

In the recruitment process, the research team first approached senior street vendors when noticing them in business, and described the motivations and objectives of our study. After getting participants' consent, we first made at least 1-hour field observations. If senior street vendors further agreed to take the interview, we conducted semi-structured interviews with them. An exception is the riders who offered transportation services with high mobility, for whom we requested interviews without observations beforehand. In total, we contacted 57 senior street vendors, of which 33 allowed the research team's observation, and 15 further agreed to take the interview. Only two vendors that we contacted were excluded due to not using mobile payments, and other non-participants refused us because of concern about the impact on business, suspicion of our objectives, or thinking that they had little valuable information to share. The participant recruitment and the following fieldwork were conducted in July and August 2021.

Table 1 describes the background of interviewed participants. Though we did not deliberately control their demographics, the female (N=7) and male (N=8) interviewees were balanced. Most participants were at a relatively low education level. We covered vendors in both selling goods (e.g., fruit and handicraft) and providing services (e.g., ride and haircut). Based on participants' descriptions, their daily income was roughly between 50 yuan (US$8) to 200 yuan (US$31). The mobile payments adoption time of participants ranged from 3 to 5 years, and mobile payments accounted for at least 50% of transactions for all senior street vendors, according to their own estimation. Note that the mobile payment percentage was influenced by a complex mechanism beyond vendors' mobile payment adoption level. For example, V5 typically ran her business near schools, and many of her consumers were primary school students who could not take mobile

Table 1. Basic Information Summary of Interviewed Senior Street Vendors. Education: Primary - Primary School, Middle - Middle School, None - Not Educated. Mobile payment platform: W - WeChat pay, A - Alipay. Vendor Category indicates whether the vendor is family-dependent (FD) or family-independent (FI).

ID	Sex	Age	Education	Location	Years of Use	Goods or Services	Price	Mobile Payment Platform	Mobile Payment %	Vendor Category
V1	M	56	Primary	City	4	Fruit	Variable	W, A	90%	FI
V2	F	53	Primary	Country	5	Pesticide	Fixed	W, A	80%	FI
V3	F	64	None	Country	5	Vegetable	Variable	W, A	50%	FD
V4	F	78	None	City	3	Handicraft	Fixed	W	70%	FD
V5	F	62	None	Town	5	Kebab	Fixed	W, A	60%	FD
V6	M	59	None	Town	4	Sugar	Variable	W, A	70%	FD
V7	F	53	Primary	Town	5	Vegetable	Variable	W, A	70%	FI
V8	F	62	None	Town	5	Fruit	Variable	W, A	70%	FD
V9	M	57	Middle	City	5	Breakfast	Variable	W, A	90%	FI
V10	M	63	Primary	City	3	Antique	Fixed	W, A	90%	FD
V11	M	63	None	City	4	Handicraft	Variable	W, A	80%	FD
V12	M	54	None	City	3	Ride	Variable	W, A	90%	FI
V13	M	69	None	Town	4	Ride	Variable	W, A	70%	FI
V14	F	72	None	Country	3	Tofu	Variable	W	50%	FD
V15	M	54	Primary	Town	5	Haircut	Fixed	W, A	80%	FI

devices, leading to a low mobile payment proportion. Most of the interviewed vendors accepted both the two mobile payment platforms except for two (V4, V14) only supporting WeChat Pay. Finally, we concluded senior street vendors into two representative categories after interviews: **family-independent (FI)** vendors, who had their own mobile devices and mobile payment accounts, and thus were accessible to all visual or audio payment signals; and **family-dependent (FD)** vendors, who relied on family's accounts, devices or only QR codes to run their everyday business due to relatively low digital literacy, and were typically limited to access payment signals on their own sides. During our recruitment, we noticed that the two categories of senior vendors had similar sizes.

4.2 Observations

Observations were performed as an initial step to get a preliminary understanding of the transactional interactions and the possible challenges for senior street vendors. After describing the objectives and getting participants' consent, the first author stood or sat by the vendors, observed the whole procedure of transactions from consumers' coming to leaving, and took detailed notes. We did not get involved in the interaction to ensure its authenticity. Among all transaction periods, we paid the most attention to interactions and challenges in the *confirmation* period, including (1) how senior street vendors verified the success of transactions through consumers' behaviors or device signals, and whether there were any inconveniences; and (2) how consumers proved the successful transactions to the senior street vendors (either actively or passively), and how vendors reacted to it. The observed challenges or difficulties (e.g., taking an extremely long time to check the payment proof) would be particularly noted and guide some impromptu interview questions. Each observation lasted from one hour to two hours till the observed interaction patterns of the specific vendor reached saturation. When participants were not willing to take the further interview, we bought commodities worth about 20 yuan (US$3) as compensation for their cooperation before leaving.

In total, about 42-hours observation data from 33 senior street vendors were collected with detailed notes. Observations covered both peak-time business (e.g., fruit selling in the evening peak) and non-peak-time business (e.g., antique vending in the early afternoon), so that we could observe payment confirmation patterns when vendors had or did not have adequate time for careful payment confirmation. We guaranteed a minimal threshold of 5 transactions for each observation to reduce the sampling bias, and most observations (28 in 33) recorded more than 10 transactions. All vendors in the observation sample adopted customer-initiated QR-code scanning for mobile money collection (i.e., presenting the QR codes to customers), and none used vendor-initiated QR-code scanners. Twenty-five senior street vendors that we observed put or stuck the printed QR code in a prominent location. Eight vendors did not make QR codes noticeable, including 2 vendors showing the printed QR code upon customers' requests for mobile payment, and 6 vendors providing the QR code in digital form such as screenshots or directly opening WeChat/Alipay (it is interesting to note that 2 vendors set screenshots of QR codes as the phone wallpaper for convenience). Section 5.4.1 provides a potential reason why some vendors preferred cash and did not advertise mobile payments.

4.3 Semi-Structured Interviews

To deepen the comprehension of mobile payment-related challenges as well as figure out the less frequent difficulties that may not happen in the observations (e.g., frauds), semi-structured interviews were conducted with 15 senior street vendors. The interviews included questions about (1) when, why and how they began to use mobile payments for money collection and the difficulties in the adoption process, (2) how they interacted with consumers before, on and after transactions to collect digital money and the perceived challenges, (3) which frauds they had met and what measures they took to prevent frauds, (4) their positive and negative experiences using mobile payments, and (5) other significant challenges they wanted to share. We provide the full interview questions in Appendix A. We discarded invasive or offensive questions through team discussion before the interview, and informed participants that they could refuse to answer any questions. Each interview lasted from 40 minutes to 1 hour, and we compensated each participant with a 50 yuan (US$8) honorarium for their time (if they felt embarrassed to accept it, we bought commodities at a similar price). Interviews with vendors were in Mandarin and audio-taped. The first author, who conducted the interviews, transcribed and translated them after all the fieldwork was finished. In total, about 13-hours interview data from 15 individual senior street vendors was collected.

4.4 Data Analysis

We analyzed the 42-hours observation notes and 13-hours interview transcripts using an open coding method [17] to let the codes and themes naturally emerge. The overall analytical process could be divided into the following three steps:

- **Initial code generation**. Two coders individually went through the notes and transcripts for multiple passes, and generated initial codes that closely described senior street vendors' challenges in mobile payment use. These codes naturally covered transactional interactions across different stages of Moneywork [76]. Examples of codes in this step included *fake screenshot of payment proof* and *concerns on business privacy*.
- **Code validation**. Through several rounds of meetings, comparisons and discussions, coding differences were resolved between the two coders to reach a consensus. Less representative or relevant codes were eliminated in this step.
- **Theme development**. Affinity diagramming [60] was further adopted to develop thematic clusters. Codes with highly similar meanings were grouped together to form high-level

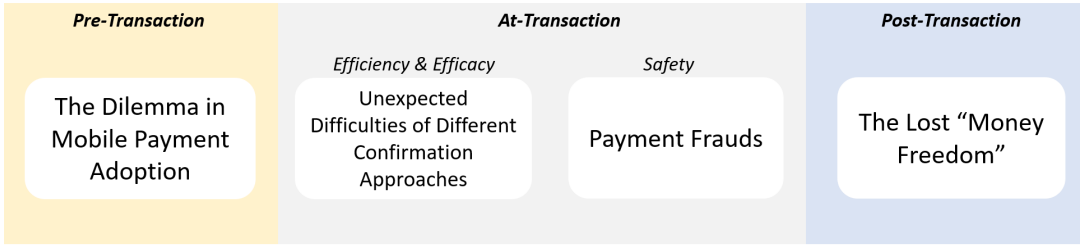| Pre-Transaction	At-Transaction		Post-Transaction
	Efficiency & Efficacy	*Safety*	
The Dilemma in Mobile Payment Adoption	Unexpected Difficulties of Different Confirmation Approaches	Payment Frauds	The Lost "Money Freedom"

Fig. 1. Overview of Senior Street Vendors' Challenges in Mobile Money Collection

themes that captured the challenge category of senior street vendors in mobile payment use. Examples of high-level themes included *the dilemma in mobile payment adoption* and *the lost money freedom*. Finally, we organized the high-level themes according to the Moneywork framework [76], distributing them to pre-, at-, and post-transaction phases to establish a clear structure.

4.5 Research Position Statement

The first author, who collected the observation and interview data, spent most of the time in China during 2010 - 2021, and thus largely experienced the whole process of the emergence and development of mobile payment in this country. Coders who analyzed the data were born and raised in China, and were accustomed to most of the daily routine in Chinese everyday life, including the business with street vendors.

5 FINDINGS

Our findings discovered four categories of senior street vendors' challenges in mobile money collection across pre-, at-, and post-transaction stages in Moneywork. Specifically, Section 5.1 described *the dilemma in mobile payment adoption* of senior vendors in *pre-transaction* adopting and setting-up period. Section 5.2 and Section 5.3 captured two critical aspects of challenges *at transactions*, when the former described *the unexpected difficulties of different confirmation approaches* regarding the transaction efficiency and efficacy, and the latter uncovered *the payment frauds* that threatened the transaction safety. Finally, at the *post-transaction* phase, Section 5.4 demonstrated *the lost "money freedom"* of family-dependent vendors under the specific sociocultural context in China. In general, these challenges reflected the contextual vulnerabilities of senior street vendors across different stages, providing insights into how to build more inclusive digital payment systems. The overview of senior street vendors' challenges is shown in Figure 1.

5.1 The Dilemma in Mobile Payment Adoption: Use Mobile Payment or Be Eliminated

Most interviewed senior street vendors in China began to adopt mobile payment during 2016-2018. Different from policy-driven or agent-driven modes of merchants' mobile payment adoption in some settings in the Global South [42, 68], senior street vendors' mobile payment adoption in China was largely *market-driven*, when vendors either chose to adopt mobile payment, or got excluded by the increasingly cashless society. In this section, we unveiled this dilemma in mobile payment adoption.

Passively adopting mobile payment facing the impact of cashless economy, instead of recognizing its benefits to use, was the common characteristic of senior vendors' motivations of mobile payment adoption. Specifically, senior street vendors adopted mobile payment because of:

(1) consumers' requests (N=7). Many vendors disclosed that they frequently received consumers' requests to pay by WeChat Pay and Alipay, some of whom even began to not take cash, in the rapid growth period of mobile payments. Thus, they had to adopt mobile payments to avoid losing potential deals. As V2 (F, 53, FI) described, "*I felt nervous when more and more people asked for WeChat Pay and Alipay. Some directly left when I said I did not have... I knew if I did not adopt them, my business would be affected. So I had to catch up with the times (to learn to use mobile payments)*"; (2) peer pressure (N=5). Some vendors realized the urgency of using mobile payments when noticing other vendors' adoption. For instance, V9 (M, 57, FI) noted, "*To be honest, I felt my income somehow reduced when other breakfast sellers began to stick QR code (to collect money) but I did not. I had to ask my son to teach me*"; (3) suggestions from family (N=3). Some vendors were advised to adopt mobile payment by more tech-savvy family members to avoid business disruption.

We noticed that such market-driven adoption, with little incentives or recognition of mobile payments' advantages at the beginning, limited some senior vendors to a minimal level of proactivity to learn the independent use of mobile payments. Many family-independent vendors (V2, V7, V13, V15) went through a family-dependent process facing the constraints such as expenses for smartphones, cost of learning, or lack of recognition and interest. Though they finally evolved to be family-independent due to various challenges (e.g., inconveniences and frauds) as well as increasing awareness of mobile payments, this process was sometimes lengthy and difficult. For example, V13 (M, 69, FI), who had little interest to learn mobile payments and spent a long period as a family-dependent receiver, described his experiences:

> "*When many customers requested me for WeChat Pay, I asked my daughter to print her QR code for me. It worked though not so conveniently, and I sometimes felt disappointed when problems such as frauds occurred... However, at that time, I did not know that buying a smartphone myself and installing it could actually make things much easier. Indeed I treated providing QR codes as a necessary task, instead of something that could save my time... Recently when I finally took the step and could get payment notifications on my own device, I would regret that I did not adopt it earlier.*"

This example illustrates how V13 initially treated the mobile payment adoption as "a necessary task" instead of a tool for "saving time", and how he went through an inconvenient family-dependent period due to it. It warned of the potential negative consequences of market-driven adoption, which not only reduced vendors' initiative during mobile payments' setting up and onboarding, but might lead to a basic or even immature mobile payment use (e.g., family-dependent use) before fully accepting it. In this process, subjective harm, with the feeling of lagging behind the trend, was also reported by some vendors, e.g., "*I realize I am really old, and can not keep up with the times*" (V14, F, 72, FD).

When vendors finally decided to accept mobile payments, challenges for setting up emerged. To prepare for mobile payment use, a series of operations on smartphones should be conducted, such as installing WeChat/Alipay mobile applications, registering mobile payment accounts and binding bank cards. All senior street vendors that we interviewed found the procedures challenging or impossible on their own, when their low digital literacy and deficient equipment conditions (e.g., no smartphone) became the major restrictions. For instance, V4 (F, 78, FD) disclosed why she could not set up her own mobile payments:

> "*I never got educated and I am illiterate. It is impossible for me to use smartphones, let alone set up mobile payments. I only hold a dumbphone to contact my family, after my eldest son told me how to dial... But (nearly) no one takes cash now. The only choice for me is to use my son's QR code.*"

In fact, no one that we interviewed set up mobile payments by themselves, even the current family-independent receivers. Turning to the family for support, such as their children, spouse or sometimes their younger brothers/sisters, was the common strategy to cope with this dilemma. Vendors who were relatively more tech-savvy only requested the family's short-term help in installation, set-up and onboarding. For example, V10 (M, 63, FD) described his adoption process, "*My son helped me install the WeChat and bind the bank card, and taught me its basic use. Till now I do not know how to install them on my own, but it has had little impact on my daily business. After all, I don't need to install them every day*". Directly requesting QR codes from family members for daily business was the choice of those with even lower literacy like V4 (F, 78, FD), who became family-dependent vendors later and relied on family's long-term support for everyday business. Nevertheless, such family-dependent mobile money collection caused further inconveniences and concerns, which is shown in Section 5.4.

5.2 Unexpected Difficulties of Different Confirmation Approaches

As vendor-initiated QR code scanning [16] was not practical in the street due to the constraints of devices as noted in Section 2.2, providing QR codes for customers to scan and pay was the only approach for senior street vendors to collect digital money. Such a *passive* money collection procedure raised challenges for the efficacy and efficiency of the payment confirmation process, especially when vulnerabilities of seniors and complexity of outdoor settings were less considered. In this section, we first described the practice of the two basic confirmation approaches adopted by vendors: *visual-based confirmation* and *audio-based confirmation*, and revealed the existing difficulties of senior vendors in the research context.

5.2.1 Visual-based Confirmation. When a payment was finished, a successful payment notification would pop up on both payer's and payee's mobile devices. However, we observed that most senior street vendors rarely relied on the pop-up notification on their own devices to confirm the payment especially during the peak time, while choosing to check the payment proof on the customers' end. When discussing why they did not visually check notifications on their own device, vendors provided three main reasons: (1) not able to access the notification on the device (for family-dependent vendors); (2) no time and no available hands to check their own devices (N=5), e.g., "*I provide haircuts for one customer after one customer, and I am not available to frequently check my phone*" (V15, M, 54, FI); (3) not able to distinguish the payment between different customers (N=1), i.e., "*I do not know who pays and who does not pay on my device; but when they show the proof to me, I can*" (V9, M, 57, FI). Only two vendors (V12, M, 54, FI; V13, M, 69, FI) claimed to take the notification on their own devices as the main proof when they were not busy.

We observed that vendors spent rather limited time (many just took a glance) when visually checking the payment information from customers. When asked about the reason, vendors attributed it more to social considerations to avoid embarrassment, instead of saving time or busyness. For example, V7 (F, 53, FI) explained her visual-based confirmation process:

> "*I just take a glance (to check the payment proof). If you spend a long time checking, it seems that you distrust your customers and that makes your customers embarrassed, who would not come to buy again... With the limited time, I only check whether the amount and (receiver) avatar are correct. It is very clear and intuitive.*"

As such, getting adequate information from the payment proof just at a glance was necessitated. V7 developed her strategy to more focus on the amount and the receiver avatar compared to inspecting the receiver name and paying time, given the short checking period. Unfortunately, frauds targeting the quick visual-based confirmation emerged, which is discussed in Section 5.3.1.

Fig. 2. An Example of Visual-Based Confirmation by a Senior Street Vendor (as a family-dependent vendor, left). As the payment notification shown by the customer (right) was the only proof that the vendor could access, she carefully checked the payment notification on the customer's device.

Difficulties of visual-based confirmation: The observations and interviews indicated that senior street vendors' degraded eyesight, especially when many of them suffered from presbyopia, greatly affected the confirmation efficiency. We observed that vendors with poor eyesight needed to pay more effort to check when customers showed the proof. The changeable lighting in the outdoor settings, such as the poor light in the evening, magnified this inconvenience. Consequently, vendors had to sacrifice the confirmation accuracy, choosing to not conduct careful manual checking, for the efficiency of the business. For example, V8 (F, 62, FD), a 62-years-old fruit seller with presbyopia, noted that "*it is difficult for me to check customers' screen... sometimes when customers voluntarily show the proof, I would trust them and let them go without checking the amount*". Alternatively, some family-independent vendors reported that due to the difficulty of visually checking, they took visual-based confirmation only as an auxiliary approach, while more relying on other methods (typically audio-based confirmation) to assist with the whole confirmation process.

Through observations, we also noticed a special difficulty of family-dependent vendors in visual-based confirmation. As family-dependent vendors were unable to receive any signals on their own devices, they could only depend on the payment proof shown by customers to confirm payments. As such, they had to cost additional labor to cautiously perform visual-based confirmation, which not only reduced their business efficiency, but also put them in a passive condition depending on customers' cooperation. V6 (M, 59, FD) described his example, "*you know, I have to make sure customers finish the payment before they leave because I can not verify on my phone. So no matter how troublesome it is, I would always request and inspect their proof*". Figure 2 shows a typical example when a family-dependent vendor carefully checks the payment information on the customer's device.

5.2.2 Audio-based Confirmation. Both WeChat Pay and Alipay in China afford sound signal confirmation after successful transactions. The payment amount is explicitly vocalized out (i.e., "*WeChat Pay/Alipay receiving xx yuan*"), while other payment details such as payment time and payer name are omitted. Vendors reported that when transactions were not dense, the audio-based confirmation was the predominant measure for payment validation, as "*it might be the most direct and convenient way... I could free my hands and eyes*" (V9, M, 57, FI).

Difficulties of audio-based confirmation: Noisy circumstances in the street and degraded hearing of some senior street vendors affected the effectiveness of audio-based confirmation. For example, V1 (M, 56, FI), selling fruits on a platform bridge above an avenue, noted that "*the traffic was very noisy and my hearing was not so good, so I could not always hear the sound (of payment proof) clearly*". As such, we observed that using external loudspeakers, which were connected to mobile devices through Bluetooth, became a common remedial strategy of senior street vendors to amplify the sound signal and thus ease audio-based confirmation.

5.3 Payment Frauds

The limited time for payment confirmation and the potentially adverse environmental factors made senior street vendors a vulnerable group of frauds. In this section, we describe mobile payment-related frauds that could be categorized into two groups: *signal-based frauds*, which counterfeited payment signals to bypass the current confirmation mechanisms; and *interaction-based frauds*, which targeted the transactional interactions that naturally developed in the street vending setting.

5.3.1 Signal-based Frauds. When senior vendors largely relied on the visual- or audio-based proof for confirmation, deceivers counterfeited fake screenshots or sounds of successful payments to perform signal-based frauds.

Fake Screenshots of Payment Proof: Using a screenshot of another payment to convince vendors that the transaction has been successful is one of the most prevalent frauds in digital payments [42]. It was also the most reported fraud in this work (N=13). Vendors disclosed that most deceivers used the screenshot of payment with the same amount and money-receiver but at a different time, making such frauds hard to perceive. Some vendors believed that such frauds specifically targeted senior vendors' vulnerabilities such as poor eyesight, low literacy and no sound signal (for family-dependent vendors). For example, V5 (F, 62, FD) described a half-year fake-screenshot fraud:

> "*One young man bought 7-yuan ($1) kebab every day... As he always voluntarily showed the proof to me, I never suspected him. Till one day my daughter (the money receiver) changed the avatar, I realized that what he showed was a fake screenshot...*"

Similarly, V14 (F, 72, FD) disclosed how she faced the challenge of fake-screenshot fraud because of poor eyesight, but had to tolerate it, "*I can not let customers wait and spend one minute to check the payment. Even if I know someone deceives me using fake screenshots, I can only trust everyone who shows the screen*". Interviews indicated that those selling goods with variable prices had a relatively lower risk of getting cheated by fake screenshots. However, these vendors also reported that some showed them the payment confirmation in the same amount but to a different receiver, which was also "*hard to detect without careful checking*" (V12, M, 54, FI).

Fake Sounds of Payment Proof: As mentioned in Section 5.2.2, family-independent receivers largely relied on the sound signal to confirm successful payment, and some might connect the mobile phone to external loudspeakers to amplify the sound signal. However, this confirmation mechanism was more fragile than visual-based checking, especially when adverse environmental factors (e.g., poor network connection) or human vulnerabilities (e.g., hardness of hearing and low literacy) were discovered by deceivers. We uncovered three kinds of frauds that counterfeited fake sounds of successful payments to bypass the audio-based confirmation:

- **Creating the sound signal using their own devices**: Some deceivers took their own mobile devices to simulate the sound signal (e.g., transferring money to themselves). For example, V7 (F, 53, FI) described that "*once a man bought vegetables worth about 20 yuan. I guarantee that I clearly heard the sound signal of the payment proof before he left. But later I*

checked my transaction record and found nothing. So I realized that he made the sound signal using his device."

- **Using others' sound signals as their payment proof**: Some vendors (e.g., breakfast providers) had a fixed busy period when a large number of transactions happened in a similar amount and time. As the sound signal did not indicate the customer's name, some deceivers declared the successful payment to leave when other customers' payment signals got broadcast. Such frauds became harder to detect when network issues and a large number of simultaneous transactions caused delayed payment signals. V9 (M, 57, FI) described a typical scenario of such frauds:

  "*Once, two people came and paid at the same time. When I heard the sound of successful payment, one guy pointed to the loudspeaker, hinting that he finished the payment; another guy showed his screen (to prove payments) and also left. However, later I found that I only received the money for one order, and realized that the first guy did not pay actually...*"

- **Paying a smaller amount that generated a similar sound signal**: Some numbers had similar pronunciations in Chinese especially in some regional dialects, which brought potential risks of frauds to some senior vendors who had hearing problems or strong accents. For example, V1 (M, 56, FI) claimed that "*I received 4 yuan (pronounced as 'si') for 10 yuan's fruits (pronounced as 'shi'), or 2 yuan for 20 yuan's fruits for at least five times, let alone those I missed.*"

5.3.2 Interaction-based Frauds. Some deceivers targeted the naturally developed transactional interactions to conduct frauds. Compared to signal-based frauds, interaction-based frauds were more likely to be ignored when few system-supported protective measures existed.

Invalid Half-done Proof Before Entering the Password: We observed that a typical process of customer-initiated QR-code-based payments for customers was (i) scanning the vendor's QR code, (ii) entering the payment amount, (iii) typing in the password, (iv) showing the proof of successful payment to the vendor, and (v) leaving. However, at step (iv), quite a few consumers (about 20% according to vendors' estimation, which was also validated in our observations) showed the screen with money amount typed in yet password not entered. We noticed that most of such consumers did not aim to deceive, and would type in the password when they left. However, part of opportunists took advantage of this half-done proof way and fled without paying. Many vendors complained about the invalid half-done proof but had to endure it, as V11 (M, 63, FD) mentioned:

  "*You have no choice but to trust them to enter the password, even if you know a small number of them would never do it... Asking them to finish payment before leaving shows how stingy you are, and may influence your future business. Sometimes you have no time to check whether they pay.*"

Excuses for Leaving Before Finishing the Payment: Different from cash transactions that had to be on-spot, mobile payment transactions could be remotely finished as long as customers scanned vendors' QR codes. It brought the chance for some deceivers to find excuses to leave and skip out on the bill eventually. Typical excuses included bad network connection, approaching buses or ridesharing cars, etc. Vendors were typically in a passive situation when customers raised excuses to leave, as "*we have to bear the risk of being cheated compared to losing a customer*" (V7, F, 53, FI).

Unfinished Transactions when Vendors Leave in a Hurry: Vendors in China were under a dynamic city administration that shifted between suppression and tolerance according to local political campaigns (e.g., suppression due to "Sanitary City" and tolerance due to "Stall Economy") [108]. When strict regulatory measures were enforced, vendors had to keep away from urban management officers when doing business in prohibited time and areas. It caused a hurry of leaving for vendors

when management officers approached, which afforded an opportunity for mobile payment-based frauds. For instance, V3 (F, 64, FD) noted:

> "*I remember that once urban management officers came suddenly and I needed to leave to avoid being fined. At that time, one man just bought 10-yuan's vegetables. He seemed considerate, quickly scanning the QR code and promising to pay; but later I realized he was a cheater... you know, several years ago when we were still using cash, I typically chose to suspend the transactions to leave in such circumstances. Now digital payments enable such transactions, but bring frauds as well.*"

As this example illustrated, compared to cash, the quick QR-code scanning enabled such immediate transactions when vendors hurried to leave. However, the risk of frauds also increased when some customers did not take necessary steps to finish transactions after QR-code scanning.

5.3.3 Strategies to Frauds: Evolving and Balancing. Most vendors that we interviewed disclosed that they had little to no knowledge of mobile payment-based frauds when they initially adopted mobile payments. Thus, developing awareness and corresponding strategies is an *evolving* process as the resilience to frauds. As V11 (M, 63, FD) noted, "*About five years ago, counterfeit money was still rampant, and there were even fraud gangs. When most people began to use WeChat and Alipay, counterfeit money became less and less, but different kinds of mobile payment-based frauds emerged and troubled me a lot. I had to 'learn from mistakes' every time I got deceived...*" For some vendors (V7, F, 53, FI; V15, M, 54, FI), frauds became an important incentive that motivated them to evolve from family-dependent use to family-independent use. After that, vendors managed to "*take mixed methods to ensure successful payments*" (V15, M, 54, FI), instead of only relying on customers' proof. In another example, V1 (M, 56, FI) adopted external loudspeakers to amplify sound signals after several times of (sound) signal-based frauds. As the interviews suggested, these measures that were "learned from mistakes" were effective in largely reducing frauds, though the costs of learning, adapting and equipping constrained some senior vendors in evolution.

On the other hand, the interviews indicated that some strategies could not evolve to a flawless status that prevented all frauds, when vendors had to consider complex social and transactional factors for business. Consequently, *balancing* the trade-off between the risk of frauds and countermeasures' influences on business was a necessary task. Specifically, vendors tried to (1) balance the confirmation efficiency and risks of signal-based frauds. Vendors believed that signal-based frauds could be much reduced when they paid adequate time for checking, though it was more applicable during non-peak time. For example, V5 (F, 62, FD) noted, "*When I am not busy, I will also check the time on customers' payment proof to make sure it is not a screenshot*"; and (2) balance the transactional trust and risks of interaction-based frauds. To reduce frauds without harming basic vendor-customer trust for long-term business, vendors considered explicitly requesting proof for some risky transactions with non-regular customers. As V15 (M, 54, FI) claimed, "*after being cheated for several times, I would ask customers to show me the proof before leaving, especially when they are not regular customers*".

5.4 The Lost "Money Freedom": When income flows into family's wallet

When using the family's account to collect digital money was adopted as senior street vendors' last choice to avoid being divided, most of their daily income flowed into the family's wallet, instead of becoming their own disposable money. It brought a less visible yet critical challenge to these family-dependent vendors: the lost "money freedom", which referred to the inability or inconveniences of vendors to freely collect, withdraw or spend the money they earned.

All interviewed family-dependent vendors disclosed that they were not accustomed to using mobile payments for daily consumption, and the disposable money to them was only cash. Consequently, additional labor to regain money freedom, i.e., addressing the gap between digital money in the family's wallet and cash of their own, became a necessity. It brought a complex social and monetary process including comparing and verifying each transaction, summing up income, communicating with family and withdrawing money from the bank. For instance, the observations revealed that family-dependent vendors sometimes immediately contacted the account owners through phone calls to validate transactions when the transaction amount was high. In another example, we observed that V14 (F, 72, FD) manually recorded every digital transaction on a physical notebook. She explained that in doing so, she could calculate digital income daily and asked her son to provide cash to her monthly:

> "*My son runs a business, too. This QR code is used for both his and my business. It is hard to distinguish between his income and mine... I record transactions in this notebook. In the beginning, we checked my income on his smartphone every day, but that was too troublesome. Now I only tell him how much I earn every month, and he gives me the money (in cash) when he visits me.*"

It was notable that such a compensatory measure for lost money freedom naturally put senior street vendors at a disadvantaged position, when their families became the money providers even if the money was earned by vendors. The family wealth model in China, especially the strong inter-generational support [28], exacerbated and complicated such imbalanced economic status caused by lost money freedom. V3 (F, 64, FD), who did not formally ask the family to give back the money she earned because of the inconvenient procedures, expressed her complaints:

> "*Always asking my son to calculate how much I earn and withdraw cash for me is really inconvenient for both of us. So I only request the cash for daily cost, which is definitely much lower than my earnings in his wallet. The remaining income is left to support his small family. However, I think he regards it as a matter of course gradually and sometimes he is reluctant to give me the money... I feel really upset when the fact is that I support him, but it seems that he gives me the money.*"

We can notice that such an imbalanced economic status, as a negative consequence of lost money freedom under the impact of mobile payment, not only caused consumption restrictions, but might bring potential family conflicts under specific sociocultural contexts.

Besides, the lost money freedom also led to senior street vendors' concerns about business privacy. Using family members' QR codes to collect money also indicated that the account owner always knew when the vendor was on the business and when not, as well as the rough income the vendor gained. For example, V11 (M, 63, FD) noted his concern, "*When my wife checks the phone, she knows how much I earn and when I do the business. Just kidding, sometimes I feel I am under surveillance...*"

5.4.1 Strategy. Unfortunately, though family-dependent vendors expressed the wish to get the "money freedom", constraints especially digital literacy limited some of them to become family-independent. For instance, V4 claimed that "*though it is troublesome (to rely on the family), it is impossible for me to use smartphones*". As such, A compromise solution was requesting cash when possible, and not advertising mobile payments (e.g., showing the QR code only when customers requested it). For example, V11 (M, 63, FD), who put his wife's QR code in his purse and only presented it when requested, described his strategy:

> "*You know, I have to get some private savings. So I request cash payment if the customer seems to take cash. Some customers of older ages also know this unwritten rule, and would even ask me whether I prefer cash.*"

6   DISCUSSION

Leveraging Moneywork as an analytical lens, this paper reports the challenges and strategies of senior street vendors in the pre-, at-, and post-transaction phases facing the increasingly cashless economy in China. We revealed senior street vendors' *passive* mobile payment adoption when being "forced" to join the mobile payment era, described their specific difficulties in payment confirmation and risks of fraud during transactions, and showed their lost "money freedom" when having to rely on family to run everyday business. These findings exhibited how practice and challenges of mobile payment adoption in street are highly situated in physical and social contexts, and uncovered rich nuances of challenges in mobile money collection beyond a binary view of "inclusion" or "exclusion". In this section, we first necessitate understanding the *contextual vulnerabilities* of underrepresented groups in mobile payment development. Then, we discuss how family serves as a cushion for older adults against technology impact in China, yet emphasize the consideration of the tension between intermediated mobile payment use and financial autonomy. We finally reflect on the heterogeneity in HCI4D in resilience, and call for support for non-users. Driven by these reflections, this work proposes design implications for mobile payment services that are secure, efficient, and accessible to vulnerable groups to achieve sustainable digital inclusion.

6.1   Beyond Transferring Value: Understanding Contextual Vulnerabilities for Senior Street Vendors in a Cashless Economy

An increasing body of work has called for taking transactions not solely as the transfer of value, but also as a financial-ecosystem constructed, physically situated, and socially influenced activity [6, 24, 52, 76]. When the rise of mobile payments has been a significant topic of financial futures [23], unpacking these contextual aspects of mobile payments for underrepresented groups is critical for understanding an overarching problem: the tension between "*what is available in terms of digital payment artifact design*", and "*what would constitute appropriate design for users who are disadvantaged in terms of income, education, and technology exposure*" [41]. In this section, we reflect on contextual vulnerabilities of senior street vendors that are largely neglected in current mobile payment system design, and suggest considering sociotechnical, situational and interpersonal contexts to better support vulnerable groups.

Prior work has warned that **sociotechnical context**, especially how the financial ecosystem is presented to end users, can contribute to individuals' vulnerabilities when adopting digital payment systems [27, 42, 43, 68, 97]. This work extends this line of work by uncovering senior street vendors' special vulnerabilities in a rather different sociotechnical background - when mobile payments become infrastructural in China [84]. As revealed in Section 5.1, senior street vendors were a passive group facing the increasing ubiquity of mobile payments, whose adoptions were largely market-driven. As such, the inadequate initiative for adoption may not only reduce the enthusiasm for learning, but might also cause subjective harm [12] when they were reluctant to adapt to the market. These findings add nuances to the recent concern about particular groups' struggles when lagging behind the ubiquity of mobile payment systems [84]. When the sociotechnical context of ubiquitous mobile payment raises the necessity of mobile payment adoption to run the business, corresponding incentives and support from society and companies are recommended to prevent magnifying the difficulty of specific groups' adoption. With the boom of mobile payment across the Global South [11, 68, 84], we suggest broad investigations to make underrepresented groups

value and accept the novel transaction system *at the beginning of its market adoption*, instead of letting them struggle to keep up with the trend.

This work also highlights the significance of considering the **situational context** to understand contextual vulnerabilities in HCI4D. Transactions under uncertain and complex physical configurations (e.g., unstable network connections, large noise and poor light) still accounted for a large proportion of informal economy in the Global South [36, 43, 59, 67]. Our findings indicated that adverse physical context often amplified senior street vendors' physical vulnerabilities, harming the efficiency and security of transactions in the *at-transaction* phase. For example, the degraded vision and hearing not only cost some senior vendors more time and effort to check the payment confirmation, but also became the targeted vulnerability by frauds as described in Section 5.3.1. Meanwhile, the street setting might suffer from large noise and poor light, aggravating the efficiency losses and security risks. These findings echo prior work which emphasized the urgent requirements to consider *situational impairments* [93, 94] when designing accessible technologies. To this end, future researchers and designers are suggested to make comprehensive in situ investigations on how transactions could happen, critically think about the situational impairments and unfavorable physical conditions, and propose specific protective interfaces to ensure the effectiveness and safety of transactions in the low-resource setting.

Finally, we underscore the consideration for **interpersonal context** for vulnerable groups. In particular, our findings provided empirical evidence on how *interactional asymmetry* [62, 76] might occur in transaction-related social interactions, and further harm the financial autonomy and transactional security of vulnerable populations. For instance, this study demonstrated some senior street vendors' *family-dependent* mobile payment use. Similar to some prior work [44, 83, 101], it shows how socioeconomically marginalized populations relied on social ties in resilience to adversity. However, Section 5.4 revealed that vendors' dependence on family members' account sharing put them at a disadvantage with lost money freedom. The interactional asymmetry also exists between customers and providers. As Section 5.3 indicates, under social barriers such as being afraid of losing customers due to being "stingy" or causing delay, an asymmetric trust mechanism developed: customers voluntarily show the payment proof. Deceivers easily bypassed it such as showing half-done proof to flee without paying. On this note, we recommend future designers to critically reflect on which social context the vulnerable groups are situated within, and how interactional asymmetry might happen and cause harm. When mobile payment-based transactions are highly socially-constructed, consideration for interpersonal context is critical to facilitate sustainable and secure mobile payment use.

In summary, we derive the contextual vulnerabilities of senior street vendors regarding the sociotechnical, situational and interpersonal context. When mobile payment development inevitably confronts complicated and varied contexts across the world, it is essential to situate the mobile payment design in specific settings and recognize the contextual vulnerabilities to enhance accessibility to underrepresented populations.

6.2 Family as a Cushion against Technology Impact: Opportunities and Challenges

A burgeoning body of work has uncovered how family members play a crucial role in technology set-up and onboarding for digitally disadvantaged older adults (e.g., [45, 69, 85]). Such support from family holds the same with regard to older adults' adoption of mobile payment, when younger family members often help seniors familiarize themselves with the use of mobile payments [68, 97]. This study extends this line of work, showing families' long-term backing as a cushion against the technology's impact on vulnerable older adults with low digital literacy. On the other hand, we also warn of underlying challenges, calling for the consideration of the tension between intermediated mobile payment use and financial autonomy.

The findings revealed the significance of families' support at every stage of the adaptation to the mobile payment era. Before the adoption, suggestions from family members motivated senior vendors to consider the use of mobile payment; during the installation and familiarization, family members were the ones senior vendors sought help from, which replaced agents' roles in facilitating setting up [42]; more notably, using family members' QR codes offered the last choice of digital money collection for senior vendors when they failed to adopt mobile payments, and contacting account owners became a routine for them to confirm and check payments. In this regard, family's support provides a dynamic and lasting cushion to prevent senior adults from being eliminated in technological innovations of payment methods, which sheds light on richer nuances of the family's backing, instead of merely a channel in short-term set-up and acceptance that prior work focused on [45, 69]. Meanwhile, it also enriched the research venue on account sharing [1, 53, 56, 72, 87] by providing new practical evidence of family's financial support with shared devices/accounts.

Indeed, the traditional family model with stronger inter-generation financial ties in many non-western cultures [51, 89] is substantial yet largely neglected in technology design. Such a family model, as a critical component of the sociocultural background, fundamentally influenced financial practice for non-western older adults [90]. How family faces the impact of technology upgrading as a whole, especially when the COVID-19 pandemic limits interactions within social "bubbles" [85], is warranted for future research. We underscore that when the current design largely ignores the role of family for vulnerable seniors to confront technology revolutions, challenges and inconveniences emerge. For instance, as noted in Section 5.4, some family-dependent vendors held concerns about business privacy and money freedom, when most transactions were transparent to the account owners. Besides, they had additional labor to repeatedly contact their family members to confirm the transactions. How to mitigate the inter-generational asymmetry when leveraging family's backing as the assets for resilience, and how to balance the tension between *intermediated mobile payment use* and *financial autonomy*, are crucial questions that future researchers should reflect on. Following these considerations, we propose implications for family-friendly design in Section 6.4.1 to facilitate senior groups in mobile money collection scenarios. On the other hand, it is also important to figure out how technology may in turn influence the family structures, when older adults, as the symbol of wisdom and authority in traditional family models [39, 92], become a more dependent group that requires younger generations' support in their everyday routine of technology use.

6.3 Rethinking the Heterogeneity in HCI4D and Support for Non-users

Resilience has been raised as a critical notion in HCI4D, when a significant body of literature investigates how vulnerable and marginalized populations respond to adverse circumstances such as crises and health challenges [49, 55, 65, 85]. In particular, Karusala et al. called for attention to differentiation among vulnerable groups in assets and constraints, which shaped how resilience was enacted [44]. This work mirrors this point, necessitating the consideration of heterogeneity in HCI4D based on evidence in a specific resilience setting: senior street vendors' endeavors to be resilient to a cashless economy. We unveiled that two major categories of senior street vendors were naturally developed in resilience according to their different assets and constraints: family-independent and family-dependent vendors. Under basic support from social ties (e.g., children's help in setting up) and efforts in learning, family-independent receivers managed to follow the trend of the cashless economy and run their business using mobile payments independently. It echoes prior research that when perceiving technology as fulfilling a need, many older adults had a strong motivation for adoption [15, 85] and had the ability of technological resilience [65, 85], instead of always being technologically inept as stereotypes believed [21]. On the contrary, family-dependent vendors also existed, who had different degrees of non-use under the constraints of digital

literacy and digital acceptance. The two groups developed various payment confirmation methods (e.g., family-independent receivers could rely on sound signals on their own devices, and family-dependent vendors had to check payment proof on customers' end), and thus encountered different frauds and challenges. To this end, we call for recognizing the heterogeneity of underrepresented and marginalized groups like seniors in HCI4D, even when their social identities were similar. A holistic view considering specialized strategies of different subgroups in resilience to technology revolutions is required to design inclusive systems.

In particular, when most prior works focused on enabling seniors to adopt technology and improving user experience after their adoption [10, 48, 63, 69], we call for more attention to non-users when their effort for technology adoption *failed*. In the context of this work, *intermediated mobile payment use* [83] supported by family became non-users' solution for resilience. Unfortunately, we found that these non-users had much extra labor in digital money collection, leading to even an efficiency decrease compared to cash-based payments. For example, Section 5.2 indicated that as family-dependent vendors could not get signals on their own devices, they largely relied on carefully checking the payment proof on customers' devices, which would be difficult and time-consuming when some of them suffered from degraded vision. It alerts us how only considering access to mobile payment services, without fully considering the financial wellbeing of particular groups (non-users in our case), can even be detrimental [20, 62]. Besides, the additional communications to account owners for payment check, income summing and cash withdrawal, as well as the concern about business privacy, also troubled senior vendors. These findings echoed prior work on the *cost of resilience* [37]. In particular, when intermediated mobile payment use became a requisite in resilience, non-users partially lost financial autonomy, a crucial factor to be included in the discourse on financial inclusion [62]. The intermediated use also harmed the financial privacy of non-users, especially when privacy challenges on account sharing are intrinsically affected by family and gender dynamics [1]. To this end, actively considering non-users' assets and constraints, rethinking how these conditions may influence their technology access, and finally reflecting on how auxiliary or substitute interfaces could be prepared in advance, are required to create sustainable forms of resilience for non-users.

6.4 Design Implications

6.4.1 Family-friendly Design: Balancing Intermediated Mobile Payment Use and Financial Autonomy.
Recent work by Muralidhar et al. called for forwarding the digital payment inclusion goals from "access" to "autonomy" to fundamentally promote marginalized groups' financial wellbeing [62]. Our findings echo this work, revealing that a substantial challenge for specific senior street vendors is the tension between *intermediated mobile payment use* and *financial autonomy*. To cope with this, we propose family-friendly design that eases mobile money collection and management in intermediated technology use, while maximally protecting financial autonomy for vendors.

First, during payment confirmation, family-dependent vendors could not receive signals on their own devices (i.e., *lost autonomy in money collection*), which lowers confirmation efficiency and increases the risk of fraud. Thus, establishing remote connections to enable vendors to receive payment signals would be beneficial. When many family-dependent vendors carry dumbphones for basic communication, an interface for automatic and timely payment information forwarding through SMS messages is simple yet practical to make senior street vendors aware of the status and amount of transactions. To ease those without dumbphones, a portable and affordable device, with a straightforward interface that could remotely connect to the account owner's smartphone and immediately voice out payments, would be useful.

More importantly, when income flows into family's wallet, family-dependent vendors have to spend much manual labor (e.g., recording and comparing transaction time and amount) to differ

their transactions from family members' own records for further withdrawal (i.e., *lost autonomy in money management*). To this end, we suggest current mobile payment systems offer a "sub-account" interface to support dependants' financial management. As the first step, this interface needs to afford generating distinct QR codes for dependants' use. After that, the system could label and group dependants' transactions to facilitate dependants' income calculation and withdrawal. It would not only ease family-dependent vendors' financial management, but also alleviate the social barrier to "request money from account owners' wallets", when the income inherently exists in a standalone sub-account. Considering that device and account sharing is a common practice in the Global South [1], the design of embedding "sub-account" interfaces might be valuable to some similar settings to enhance autonomy and privacy protection.

6.4.2 Supporting Hybrid Confirmation. Our findings revealed the difficulties and risks when vendors rely solely on single-method confirmation (e.g., visual-based confirmation on customers' payment proof). Therefore, it is a promising approach to support hybrid confirmation so that vendors could cross-validate transactions based on different signals. For instance, FinTech companies could consider designing an integrated auxiliary device connecting to mobile devices through Bluetooth, which not only embeds a loudspeaker to voice out payment information, but also contains a sufficiently-visible screen to timely show the payment amount. Such a device could fill the gap when "*no time and no available hands*" limit family-independent vendors from visually checking pop-up notifications on their own mobile devices. Nevertheless, it is significant to note that portability, feasibility and low cost are important factors for such devices to be fully accepted and adopted in the real-world setting by senior street vendors. Besides, to avoid half-done payments, "failed payment warning" is a warranted feature that supplements the current "successful payment notification". For example, a sound signal of failed-pay from vendors' devices (mobile phones or auxiliary devices) when deceivers give up payments *after scanning QR codes* might be a potentially effective measure to warn vendors of possible frauds.

6.5 Limitations and Future Work

This work conducted a qualitative study incorporating field observations and semi-structured interviews, which captured the vulnerabilities that senior street vendors experienced when they faced the impact of ubiquitous mobile payment, and shed light on implications for the inclusive design of digital payment technology. However, as a qualitative study, it is inherently limited in sample size, and may not be generalized to other contexts. More importantly, due to the on-spot recruitment when vendors were on business, we did not interview their family members, who played a crucial role in supporting senior street vendors' mobile payment use as revealed in Section 6.2. As such, the family's perceptions and challenges are not directly reflected in this work. We suggest future researchers systematically integrate the family model into mobile payment design in China. Finally, a comparative study would be also a promising direction to explore the considerations for vulnerable groups in different countries and cultures with diverse challenges in digital payment development.

7 CONCLUSION

This work makes the first attempt to understand how senior street vendors adopted and used mobile payment for money collection and what challenges they encountered in this process. Toward this goal, we conducted a qualitative study incorporating field observations and semi-structured interviews with 15 senior street vendors (age 53-72yr). We revealed the heterogeneity of senior street vendors with different levels of mobile payment use, including family-independent and family-dependent vendors. Vendors suffered from the dilemma in passive mobile payment

adoption, when they either used mobile payments or got eliminated by the cashless society. With the vulnerabilities of senior vendors and the complexity of outdoor settings, difficulties existed in both visual- and audio-based transaction confirmation approaches, such as reduced confirmation efficiency due to degraded eyesight. Frauds, either targeting the confirmation interface (e.g., fake screenshots of successful payment) or trust mechanism (e.g., half-done payment proof), also troubled vendors. Besides, for family-dependent vendors, the lost money freedom brought concerns (e.g., the exposed business privacy to family members). Based on the findings, we discuss three overarching considerations including the necessity of understanding contextual vulnerabilities of mobile payment use, family as a cushion against the technology impact in China, and the heterogeneity in HCI4D and support for non-users, which shed light on more accessible and senior-friendly mobile payment design.

8 ACKNOWLEDGMENTS

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A INTERVIEW PROTOCOL

We provide the interview questions for the semi-structured interviews with senior street vendors below. Note that we might skip some predetermined questions, and develop impromptu questions based on the pre-interview observations and their responses (e.g., "*Just now I noticed that some customers left before you received the successful payment notifications on your device. Why do you allow them to leave? Do you have some measures to prevent frauds if they don't pay?*").

Basic Information:

(1) Could you please tell us your age, hometown and education level?
(2) How long have you been a street vendor?
(3) Hong long have you used mobile payments for money collection?
(4) Which mobile payment approaches do you accept?
(5) Could you gauge the proportions of different payment approaches? (cash, Alipay, WeChat Pay, etc.)

Motivation and Practice:

(1) What motivated you to adopt mobile payments?
(2) How do you confirm that the transactions are successful? Among these methods, which one do you rely on more? Why?
(3) Would you ask customers to show proofs of successful transactions on their devices after the payment? Why?
(4) How many customers would voluntarily show payment proofs on their devices after the payment?
(5) What other mobile payment functions have you used beyond money collection? (e.g., transaction tracking, financial management, etc.)
(6) (Added as a fixed question after several interviews) Do the mobile payment accounts of the QR codes belong to you? (if yes) When and why do you check the mobile transaction record on your device? (if no) When and why do you contact the account owner to check the mobile transaction record?

Frauds:

(1) Have you experienced frauds through mobile payments?
(2) How do deceivers make frauds? Could you show any examples?
(3) How do you take action to avoid further frauds?

Benefits and Challenges:

(1) What advantages and disadvantages of mobile payment systems do you think compared to cash?
(2) Have you experienced any specific challenges when using mobile payment systems?
(3) Do you have some impressive interesting or awful experiences when using mobile payment systems?

Platform Design:

(1) Which features do you hope to add or delete in mobile payment systems for money collection?