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# BEYOND JUST MONEY TRANSACTIONS: REDESIGNING DIGITAL PEER-TO-PEER PAYMENTS FOR SOCIAL CONNECTIONS

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A Dissertation  
Presented to  
the Graduate School of  
Clemson University

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In Partial Fulfillment  
of the Requirements for the Degree  
Doctor of Philosophy  
Human-Centered Computing

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by  
Lingyuan Li  
May 2023

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Accepted by:  
Dr. Guo Freeman, Committee Chair  
Dr. Bart Knijnenburg  
Dr. Donghee Yvette Wohn  
Dr. Nathan J. McNeese



# Abstract

Financial activities, such as the exchange of money between individuals, have long been considered a crucial aspect of how people build and maintain their interpersonal relationships (i.e., a strong, deep, or close association/acquaintance between two or more people) with individuals they know because money is a sensitive social construct. In particular, over the past decade, how to conduct, manage, and experience money exchanges and processes between individuals has been dramatically transformed due to the increasing popularity of digital peer-to-peer (P2P) payment services (i.e., performing one to one online money transactions via a digital device). In this sense, digital P2P payments have shown the potential to affect how people pay and interact with each other regarding money, an important impact factor on various forms of interpersonal relationships, by facilitating direct money transactions between individuals through computer-mediated channels.

Therefore, this dissertation research is motivated to leverage a sociotechnical approach to conduct an in-depth investigation of the nuanced human experiences of personal money exchanges mediated by digital P2P payments between people who know each other and the unique role of digital P2P payments in shaping these individuals' social connections with each other online and offline. In doing so, this dissertation research aims to (i) reveal and elaborate the multidimensional influences of digital P2P payments on interpersonal relationships between people who already know each other in terms of both experiences of money exchanges and everyday social interactions; ii) advance our knowledge and understanding of how digital P2P payments systems can be redesigned to better support people's social connections with individuals they know; and iii) envision the future landscape of digital P2P payments in our increasingly networked digital society.

This dissertation research involves four studies. Grounded in 158 social media posts and 8 interviews, Study 1 explores how people perceive the increasing trend of integrating digital P2P payments with social media services (e.g., Facebook Messenger payment) and why they decide not

to use this service in their daily lives. Study 2 reports findings of a qualitative study of 31 in-depth semi-structured interviews to investigate the influences of using digital P2P payments on people's offline interpersonal relationships. Study 3 reports results of a large-scale anonymous online survey with 218 valid responses to measure the specific immediate social consequences and lasting impacts of using digital P2P payments on people's interpersonal relationships. Study 4 adopts the research through design (RtD) approach with a specific emphasis on participatory design activities to both elicit and qualitatively investigate user needs and user-generated design solutions for digital P2P payment services that can better support people's social connections.

This dissertation research thus contributes to innovating financial technologies in the perspective of Human-Computer Interaction and Human-Centered Computing by better understanding new and more complicated social phenomena and dynamics emerging in today's digital economy. First, this dissertation research offers one of the first empirical evidence to unpack and explicate the multidimensional influences of digital P2P payments on both financial experiences/processes and everyday social connections between known contacts, which is understudied in prior scholarship. In doing so, we provide new perspectives on today's technology-mediated financial life and shed light on the intertwining financial and social relationships through technology. These insights also help re-conceptualize computer-mediated interpersonal relationships in today's networked society. Second, we identify and further reflect on user-generated design recommendations and develop prototypes that highlight the importance of taking the interplay of financial and social engagement, in addition to security and privacy, into consideration when redesigning digital P2P payments platforms. Through this RtD approach, we thus rethink and envision the future landscape of digital P2P payments where such technologies can be designed, developed, and used in a more comfortable, innovative, and emotionally satisfactory way. As we are entering a post COVID-19 pandemic age, there is an increasing interest to make digital financial technologies not only secure but also more human-centered, interaction-centric, and culturally sensitive, which can be used to better support and maintain human connections through daily financial activities with or without face-to-face interaction. Therefore, in a broader sense, this dissertation research on the social values of digital P2P payments also contributes to building a more robust and inclusive digital economy in today's changing society.

# Acknowledgments

I am honored to have this opportunity to express my gratitude to everyone who has supported me during my doctoral study journey in Human-Centered Computing at Clemson University.

First and foremost, I would like to thank my advisor, Dr. Guo Freeman, for her constant guidance and patience, invaluable insights, and unwavering support throughout my academic journey. Her expertise and encouragement have been essential and critical for shaping my research trajectory and helping me grow as a HCI/HCC researcher. As a mother of two young children, a successful assistant professor, a woman in computing, and a person of color, her accomplishments have tremendously inspired me. Her resilience, determination, and unwavering commitment to students, family, and academic research are admirable and something I strive to emulate in my own life. Her mentorship has helped me not only thrive as a researcher but also as a better human being: she has shown me how to think critically, work hard, communicate effectively, and believe in myself, and for that, I am eternally grateful. Her support and encouragement have made all the difference in my research and academic journey, and I am so proud to have Dr. Guo Freeman as my advisor!

I am grateful for my dissertation committee members' constructive feedback, valuable insights, and unconditional support, including Dr. Bart Knijnenburg, Dr. Donghee Yvette Wohn, and Dr. Nathan McNeese. I will always remember and appreciate how Dr. Wohn encouraged me and guided me through some of my very first research projects during my entire PhD study journey, which tremendously helped me learn how to conduct and write HCI research. I will always remember and appreciate how Dr. Bart guided me through designing survey studies and conducting quantitative research and provided me with one-on-one guidance on doing SEM analysis with great patience. I will always remember and appreciate how Dr. McNeese was such a great collaborator for our collaborative research, who always provided highly helpful and insightful ideas and suggestions. Their insights and guidance have significantly helped me refine my dissertation research and conduct

more comprehensive and rigorous research. I also want to express my heartfelt gratitude to all the faculty and staff in the Human Centered Computing Division and the School of Computing, for providing me with a highly supportive academic environment and numerous opportunities for my professional and personal growth and development.

My sincere thanks also go to my family, friends, and loved ones for their unwavering support, encouragement, and understanding during this challenging journey. My family has been an incredible support to help me reach this moment. They are the only people in the world who could pick up my phone at 3:00 a.m. without any hesitation and complaint to enlighten and comfort me. As an international student in the USA whose PhD study was severely affected by the Covid-19 global pandemic, I could not have achieved this milestone without my parents. Their unconditional love, care, support, and encouragement carried me through all those long hours of study and many obstacles I faced.

Finally, I would like to thank all the participants and respondents who generously contributed their time, insights, and ideas to my dissertation research. Their participation and insights were vital to this work. Without their support and engagement, this research would not have been possible.

Once again, thank you all for your support and encouragement. In the end, I would like to quote Aldous Huxley, "People who are full of joy and fighting spirit, always with joy, welcome thunder and sunshine." As I am completing my PhD study, I am thankful that studying and doing research for my PhD degree has helped me become a more optimistic and energetic person with a passion for life and a positive attitude towards my career. I look forward to using the knowledge and skills I have gained through my PhD study to contribute to the future of the digital economy and our networked society!

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# Chapter 1

## Introduction

### 1.1 Background

Financial activities, such as the exchange of money between individuals, have long been considered a crucial aspect of how people build and maintain their interpersonal relationships (i.e., a strong, deep, or close association/acquaintance between two or more people) with individuals they know because money is a sensitive social construct. For example, psychologists found that money could positively change people's motivations and their behaviors toward others [228]. Wood et al. revealed that people's perceptions of their social relationships improved as their financial well-being improved [244]. Additionally, strong financial well-being may strengthen established interpersonal relationships because not worrying about money would avoid a significant source of potential conflict [244].

In particular, over the past decade, how to conduct, manage, and experience money exchanges and processes between individuals has been dramatically transformed due to the increasing popularity of digital peer-to-peer (P2P) payment services (e.g., Venmo, Zelle, Apple Pay, Samsung Pay, Cash App, etc) (see Fig 1.1), which further complicates how people interact with each other regarding money. In contrast to traditional payment methods such as cash, check, and credit/debit cards, digital P2P payment apps allow people to easily make instant and precise money transactions without the limits of time and location, leading to more effective ways to manage personal money transactions [161]. In addition, though these P2P payment applications are often used on mobile devices such as smartphones and tablets, they are qualitatively different from general mobile pay-



Figure 1.1: Digital P2P payments (AARP.org)

ments in nature. Mobile payments are broadly defined as any payment through a mobile device, which can include initiating, authorizing, and confirming both consumer-to-business payments or payments between individuals [12]. While this definition primarily focuses on the affordance of financial technologies (e.g., mobility and electronization), digital P2P payments focus on the purpose of the payment and who can be involved in the transaction, regardless of the platforms (mobile or Web). They have been widely used for personal affairs between individuals, such as splitting a bill between friends or acquaintances [71] (see Fig 1.2). In this sense, compared to traditional payment methods and general mobile payments (i.e., any payment through a mobile device, including initiating, authorizing, and confirming both consumer-to-business payments or payments between individuals [12]), digital P2P payments have shown the potential to affect how people pay and interact with each other regarding money, an important impact factor on various forms of interpersonal relationships [33, 78, 255], by facilitating direct money transactions between individuals through computer-mediated channels.

Focusing on these new phenomena, a growing body of research in Human-Computer Interaction (HCI) and Human-Centered Computing (HCC) has investigated the social implications of using digital P2P payment apps. For example, Acker et al. analyzed how Venmo supported sociality, payment earmarking, and the use of Emojis [2]. Unger et al. further discovered that new users of Venmo only tended to interact with those who initiated such interactions and no one else [227]. Others identified factors that affected the behavioral and use intention of P2P payment apps,

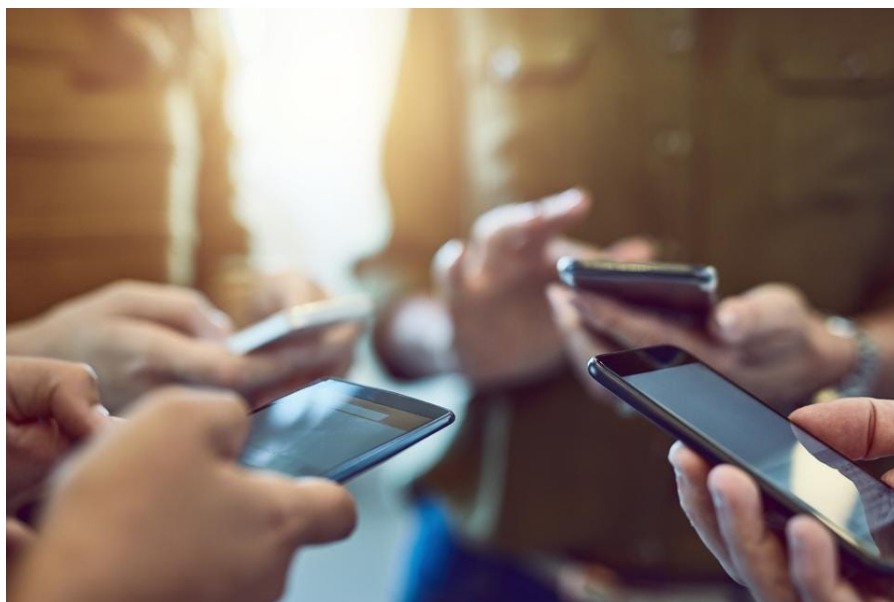


Figure 1.2: Splitting a bill among friends at the moment via P2P payments (Forbes)

including perceived trust, perceived usefulness [83, 98], and the role of social relationships [255]. Collectively, these studies highlight the dual functionalities of popular digital P2P payment apps - for both making transactions and socializing [255].

## 1.2 Problem Space and Motivation

However, this small body of research tends to mainly focus on the influences of using P2P digital payment apps on certain online social behaviors but does not paint a comprehensive image of how and why this new payment method, which differs from traditional payment methods such as physical money (i.e., cash), may also lead to new and complex influences on people's offline social lives, such as their existing relationships with people they know (e.g., friends, family members, etc) when money transactions are involved.

We believe that investigating the influences of using digital P2P payments on people's offline social relationships is crucial to HCI research for two reasons:

First, exploring the new role of financial technologies, digital cash, and mobile money in our daily lives is a long-standing focus in HCI and HCC, leading to emerging research on designing digital and new media with monetary and financial interactions, how to manage personal finance digitally, and the so-called "Financial Citizenship" in the modern society, among others [16, 99, 114]. As

the boom of digital P2P payments continues to reshape the existing socioeconomic model and social structure in today’s digital society [251], there is an urgent need for more in-depth investigations into the potential impacts of adopting digital P2P payments on our everyday interactions with money and with others, especially in comparison to the most established and commonly used monetary exchange method (i.e., cash).

Second, existing technical reports and prior work have shown that using digital P2P payments does impact people’s offline social relationships. For example, a 2018 survey conducted by Zelle indicated that more than half of the general population (54%) would keep following up with their friends until they got money back if their friends did not pay the share of a group gift [253]. Tang et al. mentioned that digital transactions via Venmo and WeChat Pay can benefit existing friendships by mitigating social awkwardness [220]. In particular, people are more likely to use digital apps to communicate with their weak social connections about debt and owed money than requesting money in person [172]. However, there is limited work to explore how and why such impacts happen and how actual digital P2P payments users perceive such impacts, which is crucial to better unpack the increasingly complex interplay between the booming digital economy, technology-mediated interactions around money and financial services, and people’s online and offline social lives.

These limitations thus motivate this dissertation research to leverage a sociotechnical approach to conduct an in-depth investigation of the nuanced human experiences of personal money exchanges mediated by digital P2P payments between people who know each other and the unique role of digital P2P payments in shaping these individuals’ social connections with each other online and offline. In doing so, this dissertation research aims to (i) reveal and elaborate the multidimensional influences of digital P2P payments on interpersonal relationships between people who already know each other in terms of both experiences of money exchanges and everyday social interactions; ii) advance our knowledge and understanding of how digital P2P payments systems can be redesigned to better support people’s social connections with individuals they know; and iii) envision the future landscape of digital P2P payments in our increasingly networked digital society.

Specifically, this dissertation research explores the following research questions:

**RQ1: What are the interaction dynamics of using digital P2P payments between people with existing relationships (e.g., friends, family members, and co-workers) in terms of different modes (e.g., face-to-face vs. remote, synchronous vs. asynchronous),**

usage purposes and contexts, frequency, and recipient/sender?

**RQ2: How do people perceive and experience both positive and negative impacts of using digital P2P payments on their interpersonal relationships with people they know?**

**RQ3: How can future digital P2P payments systems be designed to better support people’s social connections with individuals they know?**

Although digital P2P payments have been used between strangers (e.g., Instagram influencers and fans) and between small businesses and individual customers, in this dissertation research, we focus on people who make personal money transactions via digital P2P payments with those who have an existing interpersonal relationship with them, including close acquaintances, colleagues, co-workers, friends, family members, neighbors, partners, and so forth. In particular, *interaction dynamics* refer to how people conduct digital P2P payments with those they have existing relationships with from the dimensions of modes, usage purpose and contexts, frequency, and who is involved in the money transactions. Regarding *modes*, we understand that personal money transactions through digital P2P payment apps can be conducted face-to-face when users are co-located or remotely when users are geographically separated; personal money transactions through digital P2P payment apps can be conducted synchronously when both the sender and recipient are processing the transfer in real-time or asynchronously when only one party of the transaction is active at one time. Regarding *usage purposes* and *contexts*, we investigate and summarize what people make personal money transactions via digital P2P payments for, such as splitting dinner bills, gifting money, etc. Regarding *frequency*, we examine how often people make personal money transactions via digital P2P payments with those they already know in daily life. Regarding *recipient/sender*, we focus on usually who people make personal money transactions via digital P2P payments with and what relationships between them are.

### 1.3 Structure of this Dissertation

This dissertation includes nine chapters. Chapter 1 introduces background and motivations to conduct this research. Chapter 2 reviews relevant literature regarding computer-mediated interpersonal relationships, money transactions in interpersonal relationships, and digital P2P payments as well as highlights existing research gaps regarding the interplay between digital P2P payments

and interpersonal relationships. Chapter 3 describes three main research questions that guide this research and outlines four studies to address these research questions. Chapter 4 reports findings of Study 1 (qualitative analysis of 158 social media posts and 8 interviews) that focuses on the non-use of digital P2P payments. Chapter 5 reports findings of Study 2 (qualitative analysis of 31 in-depth interviews) to explore how and why digital P2P payments may lead to new and more complex influences on people’s offline interpersonal relationships. Chapter 6 describes Study 3, a large-scale online survey study (N=218), to further confirm qualitative findings of the previous studies and offer empirical evidence of several significant differences between using digital P2P payments versus traditional payment methods (i.e., physical money) in terms of immediate social consequences of such transactions, lasting impacts on people’s interpersonal relationships, and perceived usability of the given payment method and present specific improvement suggestions from respondents. Grounded in these findings, Chapter 7 reports findings of Study 4, which adopts a research through design approach [258, 259] to further advance our knowledge and understanding of how digital P2P payments systems can be redesigned to better support people’s social connections with individuals they know by leveraging participatory design (PD) activities [196, 211]. Chapter 8 discusses how findings of all 4 studies collectively address the research questions in this dissertation. This chapter also explains how this dissertation research extends our existing knowledge on computer-mediated interpersonal relationships and the nuanced role of technology-mediated money transactions in shaping people’s social experiences and social connections with individuals they know. Focusing on future implications and takeaways for HCI research, this chapter ends with envisioning the future landscape of digital P2P payments uses and services in our increasingly networked digital society. Lastly, Chapter 9 summarizes the contributions of this dissertation to HCI and HCC and future work.



## Chapter 2

# Literature Review

This dissertation research is grounded in three existing bodies of literature in HCI/HCC research. Prior work on computer-mediated interpersonal relationships is examined in Section 2.1 to shed light on how digital technologies influence daily lives and affect people’s personal relationships and social connections. As money is a sensitive and complex component of everyday life, scholarship on the unique role of financial transactions in interpersonal relationships is presented in Section 2.2. Section 2.3 describes P2P payments as emergent digital financial technologies to highlight the potential of these computer-mediated payment methods to dramatically shape people’s lives financially and socially. Section 2.4 summarizes research gaps in existing literature, which motivate this dissertation research.

### 2.1 Computer-Mediated Interpersonal Relationships

Hassenzahl et al. [81] suggested that the Beatles’ song “All You Need is Love” summarizes typical psychological studies of human needs for relationships in the past 60 years: the general feeling of being related to others, in other words, establishing interpersonal relationships, is crucial to people’s life satisfaction and happiness. Most social science studies appear to agree that an interpersonal relationship refers to a strong, deep, or close association/acquaintance between two or more people, involving experiences that range from the mundane to the aesthetic [189], and as a specific sort of knowing, loving, and caring for a person [95]. Such relationships are demonstrated as various forms such as friendship (a freely chosen association), family (which establishes roles and

identities), and romance (based on passion, intimacy, and commitment).

How do computing technologies affect these above-mentioned interpersonal relationships? A large body of literature in computer-mediated communication, human-computer interaction, and psychology has explored how diverse social technologies such as social networking sites [149, 179, 198, 239], online forums [146], online games [18, 140], live streaming platforms [116, 126], short video sharing [9, 64, 149], and immersive social virtual reality [67, 133] have dramatically transformed the ways people interact, socialize, and build relationships with one another. Collectively, they have pointed out the complicated nature of computer-mediated interpersonal relationships and social technologies as a double-edged sword in supporting and facilitating online interactions [171]. For example, in social psychology, electronic communication presents a paucity of social cues and context information [102], which leads to various debates and negative perspectives on the relationship among the Internet, digital devices and interpersonal interaction. Prior studies have also shown that computer-mediated communication is a cold and impersonal medium where emotions are very difficult to express [52, 212] and thus individuals tend to be less emotional and more detached in front of monitors or phone screens, making communication more task-oriented and less personal [185]. Others highlighted that with the increased use of the Internet, social presence and social affection are diffused or missing [187] and a time-place displacement may be created, which can decrease communication, erode social connections, and increase feelings of personal loneliness and depression [34, 35]. Additionally, mobile technology may gradually decrease the communication of intimate feelings and emotions [112].

Many other studies offer contrasting images regarding the interpersonal perspective of computer-mediated technology. On the one hand, such technology offers and increases the ease of forming and maintaining relationships over time, geographic, space, cultural, physical limits [25, 74, 77, 120, 197]. On the other hand, the reduced-cues environment, a chosen degree of identifiability to others and a forum to express facets of one's self make people feel less burdened and anxious when interacting with others in a computer-mediated context rather than a face-to-face interaction scenario [155, 178], especially much more helpful for certain community such as people who indicate a high level of shyness but still desire to be sociable [199]. This may promote and support healthier and emotionally fulfilling interactive experiences. For example, Lenhart et al. have found that Instant Messaging provides people with a better environment to discuss topics that are uncomfortable to talk about in face-to-face situations [113]. Besides, even sharing and browsing

news feeds on social media have become a way to maintain a friendship in the digital era [207]. In this sense, social technologies both promote intimate social connections and make people more insecure and vulnerable [225].

In summary, the varied degrees of fidelity and modality brought by various computer-mediated communication technologies have led to the increasing complexity to establish, maintain, and develop modern interpersonal relationships [153, 160, 201]. They have also further complicated how money is exchanged between known individuals through technology (rather than as physical money like cash), which plays a critical role in interpersonal relationships.

## 2.2 Financial Transactions in Interpersonal Relationships

Money, as a social construct of psychological and cultural power [80, 137, 208], is a sensitive and complex component of everyday life and can significantly affect people's relationships with each other. For example, even mentioning money to people can result in potential cognitive, motivational, emotional, and behavioral changes [229]. Indeed, people often take their emotional, historical, and personal backgrounds when making financial decisions [99]. Therefore, every money transaction, including spending, lending, borrowing, changing, and giving, is a form of interpersonal communication that involves various currency and financial instruments in social interactions [99]. According to Zelizer, monetary payments fall into three categories: compensation (direct exchange), entitlement (the right to a share), and gift (one person's voluntary bestowal on another) and each monetary payment implies a different set of social relations and systems of meanings [252]. In this sense, tipping as a reward for good service can also express interpersonal attraction between consumers and servers [129]; political donations from individuals may represent one's social and emotional support to the candidate [91]; gift-giving in business activities for *guanxi* (i.e., building connections to secure favors in personal relations), which is common in Asian culture, involves implicit social reciprocity and social norms [128] and may even lead to a different construct of interpersonal relations such as corruption [148].

As digital banking, online payments, and virtual currencies boost, technology-mediated transactions have been embedded in many aspects of people's social interactions and have inspired a growing research agenda in HCI/HCC. Such research has explored how to design digital and new media with monetary and financial interactions [99], new ways to manage personal finance digitally

[114], and the emerging “Financial Citizenship” in the modern society [16]. They have also explored various impacts of technology-mediated money transactions on people’s online relationships. Examples include content monetization through virtual gifting on live streaming platforms, which has the potential to build communitive and reciprocal relationships between streamers and viewers [254]. In gaming, the perception, acquisition, and use of virtual currencies can critically shape online gamers’ behaviors and experiences. For example, younger gamers are more comfortable with maintaining their social relationships by sending virtual gifts in gaming [237]. Spending in gaming (e.g., using real-life money to buy more advanced weapons in games) may also undermine social relationships between players who pay and who do not pay [117]. In addition, blockchain technologies allow anonymous online strangers to collaboratively invest and securely trade their investments, which are transforming how people collaborate, build relationships, and identify themselves in financial transactions [63].

In general, existing research has highlighted the potential role of technology-mediated money transactions in both hindering and supporting how close interpersonal relationships can be built and developed [142]. For example, Wherry et al. described the possible awkwardness, obfuscation, and negative reciprocity associated with behaviors of lending money to friends and kin and/or refusing lending [241]. Similarly, Zelle’s 2018 survey showed that regardless of their different ages, more than half of participants would keep following up with their friends who owed their money at least weekly until they got their money back [253]. Jiang et al. also found that when money is involved, people tend to consider that they are in a business-like relationship. Therefore, people tend to express less emotions in financial transactions, as such emotional expressions can be viewed as inappropriate and not objective [97]. On the flip side, financial provision (e.g., donation) in live streaming is viewed as an important form of social support from viewers to streamers [243]. In addition, red packets (lucky money) through WeChat have become a unique way to manage and strengthen group dynamics in interpersonal relationships in China [245].

As financial technologies are rapidly evolving, how people deal with money in their interpersonal relationships through technology is becoming even more diverse [99]. In particular, digital P2P payments have become an increasingly popular financial technology for people to deal with money with a peer, rather than a business, which we detail in the next section.

## 2.3 Digital P2P Payments

Today's digital economy continues to emphasize more convenient and secure financial transactions and a modern, cashless lifestyle. For example, Americans' use of paper money for P2P payments dropped below 50% for the first time ever in 2021 while usage of online services for interpersonal payments nearly doubled when compared with 2020 [51]. Following this trend, digital P2P payments have become a popular and widely accepted way to make online money transactions between friends, family, and co-workers [71]. Briefly defined, digital peer-to-peer payment is a type of money transactions that allows the transfer of funds between two individuals using their banking accounts or credit/debit cards through an online or mobile app [222].

This payment method is often considered to be easy, convenient, and swift. It is easy to set up: users sign up for an account and then link a bank account or credit or debit card to it. It just needs a few seconds and clicks to send money: users choose a receiver, type the amount of the funds, then submit the payment [165]. There is also an emergent trend to integrate social interaction with money transactions through digital P2P payments, such as Venmo's social awareness stream that allows users to craft playful payment notes to enhance their experiences of financial transactions [36]. In general, there are four main types of digital P2P payment apps on the market based on their different business models [21].

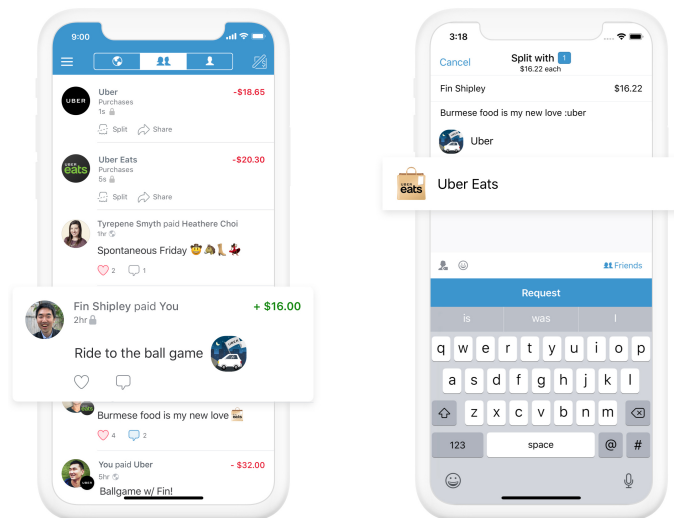


Figure 2.1: Type 1 standalone vendors - Venmo: social feed of transactions (left), splitting (right) (Business Wire)

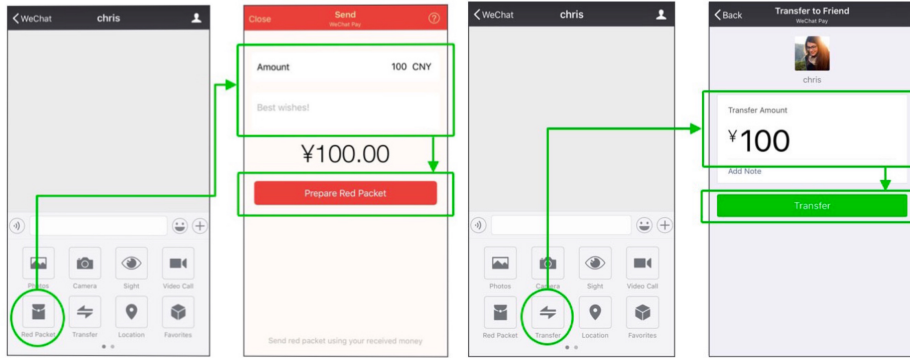


Figure 2.2: Type 2 social media platforms - WeChat Pay: red packet (left) and regular transfer (right) (WeChat Help Center)

The first type is standalone vendors (see Fig 2.1), such as Venmo, PayPal, Cash App, Alipay. These apps are non-bank providers of electronic P2P payments between individuals [26]. Users can keep their money in their wallets before outsourcing it to bank accounts. Venmo is the best examples of these standalone type apps. PayPal was the most downloaded P2P payment app worldwide, with 56.6 million downloads in H1 2021 [110].

The second type is based on social media platforms (see Fig 2.2). For example, WeChat and Facebook Messenger enable free digital P2P payments integrated with sociability within their mobile apps or websites. Both WeChat Pay and Facebook Messenger Pay stem from what originally was a social platform and do not need to be a separate stand-alone app to function. In this case, Facebook Messenger Pay inherits a huge potential user base from Facebook Messenger’s more than 1 billion active monthly users [26] and WeChat Pay had more than 900 million users worldwide in



Figure 2.3: Type 3 mobile OS centric services - Apple Pay (AppleInsider)

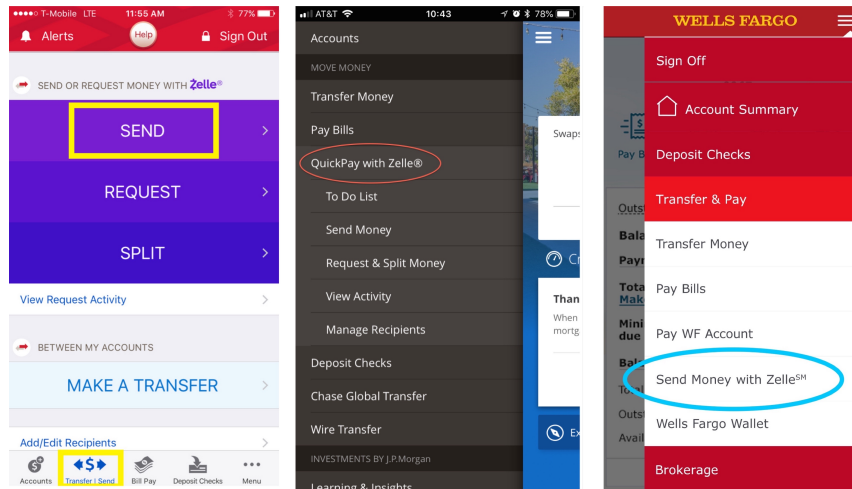


Figure 2.4: Type 4 bank-centric services - Zelle: e.g., built in BOA (left), built-in Chase Bank (middle), built-in Well Fargo (right) (Christus Ministries, Swapsy, Business Wire)

2021 with WeChat’s 1.24 billion active users [92].

The third type is based on mobile operating system (OS) centric services (see Fig 2.3). Digital wallet platforms including Google Pay, Apple Pay and Samsung Pay allow users only to make P2P payments on mobile Android, Apple or Samsung devices.

The fourth type is bank-centric services (see Fig 2.4). Financial institutions are also creating their own P2P payment platforms such as JPMorgan Chase QuickPay, Wells Fargo SurePay and so on [26]. Zelle is also one of the bank P2P providers. It has partnered with leading banks and credit unions to provide services within their banking apps.

Today, especially for millennials, digital P2P payments have been so seamlessly integrated with their daily lives that “Venmo” and “PayPal” have even become a verb [48, 165]. According to the report published by Allied Market Research in September 2021, the global P2P payment market generated \$1,889.16 billion in 2020, and is estimated to garner \$9,097.06 billion by 2030, witnessing a compound annual growth rate of 17.3% from 2021 to 2030 [180]. The increasing focus on contactlessness emerging in the COVID-19 global pandemic also seems to place an even higher demand on digital P2P payments. Fiserv research reported that nearly 4 out of 5 (79%) of consumers used digital P2P payments in some form through their financial institution or through a non-financial company in 2020 [49]. This shift to digital transactions during COVID-19 also has pushed more older users into digital P2P payments platforms than ever before, as Derek Swords, Fiserv’s Vice President of Product Management, said, “We’ve seen a lot more older Americans taking on Zelle

and using it for things that are very specific to how we’re living today” [183]. In general, the pandemic-driven explosion of online payments has made the usage of digital P2P payments across various demographic groups on the upswing.

## 2.4 Summary of Research Gaps

Previous research has shown that various digital P2P payment apps have been extensively used for a variety of money exchanges between individuals, including splitting bills, sharing rent, and transferring between friends [71, 78, 82]. Therefore, a growing body of research has explored the functional design [1, 38, 101, 226] and technical principles [107, 209] of digital P2P payments. These studies have also investigated factors that may affect the behavioral and use intention of P2P payment apps, including perceived trust, perceived usefulness [83, 98], and the role of social relationships [255]. Some others investigated the emerging new online social patterns mediated by digital P2P payments apps. For example, Acker et al. analyzed how Venmo supported sociality, payment earmarking, and the use of Emojis [2]. Unger et al. examined Venmo transactions to identify its online community structure, which revealed that new users of Venmo only tended to interact with those who initiated such interactions [227]. Collectively, these studies highlight the dual functionalities of popular digital P2P payment apps - for both making transactions and socializing [255].

However, two main research gaps have emerged in existing scholarship on digital P2P payments in HCI. First, the prevalence and far-reaching influences of digital P2P payment apps have highlighted the dramatic and pervasive behavioral changes in how people deal with money through technology in their everyday lives. Yet, these profound influences also point to the urgent need for further investigating how such new behavioral patterns of money transactions between individuals (e.g., the reduced use of physical money such as cash) may affect people’s interpersonal relationships with those they know when money is involved, because money is a sensitive and complex component of everyday life and can significantly affect people’s relationships with each other.

Second, some previous studies indeed have highlighted making transactions and socializing online as the dual functionalities of popular digital P2P payment apps [1, 2, 255]. This small body of research tends to only focus on the influences of using P2P digital payment apps on certain online social behaviors. However, using digital P2P payments may also complicate how people deal with



those whom they already know in the offline world regarding money, which is understudied.

These research gaps thus motivate the research questions that this dissertation research endeavors to address, which are outlined in the next chapter.

## Chapter 3

# Research Questions and Overview of Studies

To address the research gaps detailed in the last chapter, the dissertation research explores how and why digital P2P payments may lead to new and more complex influences on people's social connections, such as their offline interpersonal relationships with people they know (e.g., family, friends, and coworkers). In doing so, it is essential to first generate an overall understanding of people's usage patterns of digital P2P payments. Following this, more in-depth empirical investigations are needed to explore the interplay of the use of digital P2P payments and people's interpersonal relationships with known contacts. Lastly, grounded in these empirical findings and adopting a research through design approach [258, 259], design recommendations and suggestions should be identified and evaluated to further advance our knowledge and understanding of how future digital P2P payments services can be redesigned for better supporting people's social needs in their personal money transactions.

Specifically, this dissertation research addresses three main research questions:

**RQ1: What are the interaction dynamics of using digital P2P payments between people with existing relationships (e.g., friends, family members, and co-workers) in terms of different modes (e.g., face-to-face vs. remote, synchronous vs. asynchronous), usage purposes and contexts, frequency, and recipient/sender?**

**RQ2: How do people perceive and experience both positive and negative impacts**

of using digital P2P payments on their interpersonal relationships with people they know?

**RQ3: How can future digital P2P payments systems be designed to better support people’s social connections with individuals they know?**

Although digital P2P payments have been used between strangers (e.g., Instagram influencers and fans) and between small businesses and individual customers, in this dissertation research, we focus on people who make personal money transactions via digital P2P payments with those who have an existing interpersonal relationship with them, including close acquaintances, colleagues, co-workers, friends, family members, neighbors, partners, and so forth. In particular, *interaction dynamics* refer to how people conduct digital P2P payments with those they have existing relationships with from the dimensions of modes, usage purpose and contexts, frequency, and who is involved in the money transactions. Regarding *modes*, we understand that personal money exchanges through digital P2P payment apps can be conducted face-to-face when users are co-located or remotely when users are geographically separated; personal money exchanges through digital P2P payment apps can be conducted synchronously when both the sender and recipient are processing the transfer in real-time or asynchronously when only one party of the transaction is active at one time. Regarding *usage purposes* and *contexts*, we investigate and summarize what people make personal money transactions via digital P2P payments for, such as splitting dinner bills, gifting money, etc. Regarding *frequency*, we examine how often people make personal money transactions via digital P2P payments with those they already know in daily life. Regarding *recipient/sender*, we focus on usually who people make personal money transactions via digital P2P payments with and what relationships between them are.

To address these research questions, four studies were conducted (see Fig 3.1). To address RQ1, Study 1, Study 2, and Study 3 contribute to obtaining a comprehensive understanding of people’s interaction dynamics of digital P2P payments. In the context of the increasing trend of integrating P2P payments with social media services (e.g., Facebook Messenger payment), Study 1 reports findings of a mixed-method study (based on social media data and interviews) that focuses on why people do not use such type of digital P2P payments in social life as well as the advantages and disadvantages that digital P2P payments can bring to people, using Facebook Messenger payment as an example. Following Study 1, Study 2 uses in-depth semi-structured interviews to focus on people’s in-depth personal experiences of using digital P2P payments in their social lives, which sheds light on

people’s usage patterns of digital P2P payment apps regarding modes, usage purposes and contexts, frequency, and recipients/senders. And Study 3 further investigates people’s digital P2P payments usage habits in terms of modes, usage purposes and contexts, frequency, and recipients/senders using a large-scale survey study.

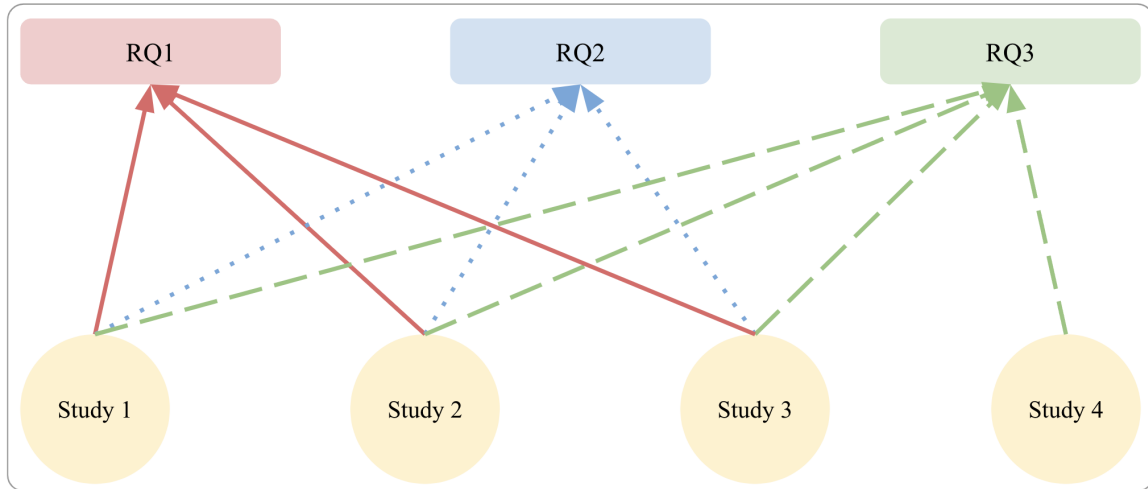


Figure 3.1: Addressing RQs through four studies

To address RQ2, Study 1, Study 2 and Study 3 collectively explore people’s perception of how using digital P2P payments can influence their interpersonal relationships with their known contacts both negatively and positively. Study 1 reveals how social P2P payments - digital P2P payments integrated in social networking platform (e.g., Facebook, Messenger, etc) - may reshape people’s building interpersonal relationships with individuals they know. Study 2 further investigates immediate consequences and lasting impacts of digital P2P payments on people’s existing interpersonal relationships. Study 3 leverages a large-scale online anonymous survey study to confirm the qualitative findings of Study 1 and 2 by using a larger sample and quantitatively measuring the specific influences of digital P2P payments on people’s existing interpersonal relationships and how these influences are associated with each other.

Findings and insights from all studies contribute to addressing RQ3. Study 1, 2, and 3 each highlights actual digital P2P payments users’ own reflections and critiques on how future digital P2P payments services can be redesigned to better serve their social needs with people they know. By adopting a research through design approach [258, 259], Study 4 especially focuses on collecting, summarizing, synthesizing, and incorporating user-generated design insights and recom-

mendations in the redesign process through participatory design activities to further advancing our knowledge and understanding of how future digital P2P payments services can be redesigned for better supporting people's interpersonal relationships through personal money transactions.

## Chapter 4

# Study 1: Why Do People Not Use Digital P2P Payments?

As money and digital P2P payments experiences have become an emerging research agenda in HCI, prior studies have focused on the factors that promote the use of digital P2P payment services as well as related design implications. Yet, few have investigated why people decide not to use such services (e.g., technology non-use) and how people perceive the increasing trend of integrating digital P2P payments with social media services. Therefore, Study 1 attends to the unsuccessful story of Facebook Messenger payment, a seeming convenient, simple, and promising digital P2P payments platform with a potential enormous user base to explore (1) why people are unwilling to use certain digital P2P payments platforms; (2) their perceptions of further integrating digital P2P payments with social media services; and (3) design suggestions for motivating people's future use of digital P2P payments.

In doing so, 158 social media posts and 8 interviews with participants who had experience with Messenger payment were qualitatively analyzed. Factors that hinder people from using Messenger payment and their perceptions of integrating P2P payments with social media were then identified.

## 4.1 Methodology

### 4.1.1 Data Collection

Two types of data were collected in this study. We used exclusive sampling to collect social media posts and comments. First, we used keyword searches (e.g., “Messenger payment”, “Facebook Messenger payment” and “social media P2P payments”) on Google to collect people’s self-reports regarding their views, experiences, and attitudes toward Messenger payment and the design of integrating P2P payments with social media that were posted on any online website or platform. We did not limit our search for any specific dates or years. Initially, we collected all posts and threads that Google retrieved. After filtering irrelevant posts (e.g., a description of how Messenger payment works; or emoji only), 158 valid posts and comments that explicitly expressed people’s specific opinions from online forums (e.g., Reddit), news sites (e.g., CNET), and social media (e.g., Facebook) were collected.

Second, we posted a recruitment message on Facebook and Reddit to recruit interviewees who had experienced Messenger payment and who were willing to be interviewed as voluntary participants. A snowball sampling was also used. All respondents who agreed to participate were interviewed. As a result, eight semi-structured in-depth interviews were conducted via text or face-to-face chat based on interviewees’ modality preference in November 2019. Interviews lasted from 30 to 40 minutes. Interviewees held diverse occupations (e.g., student, pastor, and engineer) and aged 22 to 41 years old. Four of them are women, and four are men. All interviewees were located in the USA. Table 4.1 summarizes interviewees’ demographics.

Table 4.1: Interviewees’ Demographics

<b>ID</b>	<b>Gender</b>	<b>Age</b>	<b>Occupation</b>
I1	Woman	29	software engineer
I2	Woman	24	remote client specialist
I3	Man	22	software engineer
I4	Woman	23	student
I5	Man	23	student
I6	Man	22	student
I7	Woman	23	process engineer
I8	Man	41	pastor

Interviews started with demographic questions and focused on what and why people liked and/or disliked Messenger payment (see Appendix A). Example questions included “*What advan-*

*tages/disadvantages do you think Messenger payment has over other payment apps?”, “What do you think about integrating P2P with social media such as Facebook?” and “How, if at all, did you decide not to use Messenger payment?”*

### **4.1.2 Data Analysis**

We then used an empirical, in-depth qualitative analysis [217] of the collected data to explore people’s views of using/ not using Messenger payment and attitudes toward integrating P2P payments with social media. We sought first-person, subjective, narrative accounts of their experiences in social media posts and interviews. Our analytical procedures focused on eventually yielding concepts and themes (recurrent topics or meanings that represent a phenomenon) rather than agreement – because even if coders agreed on codes, they might interpret the meaning of those codes differently [138]. Therefore, we did not seek inter-rater reliability in our analysis but endeavored to identify recurring themes of interest, detect relationships among them, and organize them into clusters of more complex and broader themes.

Specifically, our analytical procedures were: 1) we closely read through the collected data to acquire a sense of the whole picture as regards how people perceive and experience Messenger payment and collectively identified thematic topics and common features in the data (e.g., purposes, advantages, disadvantages, and challenges) for further analysis; 2) we carefully examined and re-viewed the thematic topics (e.g., the way people got to know Messenger payment) and developed sub-themes (e.g., late into the market; established network already on other payment apps); 3) we collaborated in an iterative coding process to discuss, combine, and refine themes and features to generate a rich description synthesizing participants’ perceptions and experiences of Facebook Payment and attitudes toward integrating P2P with social media.

## **4.2 Findings**

Overall, participants expressed their unwillingness to use Messenger payment - though they had encountered and/or experienced this service before, none was using it as of the time of the interview. In addition, more than half (58.2%) of the social media posts showed negative attitudes toward Messenger payment. We first unpack factors that hinder people from using Messenger payment. We then explore how such unwillingness may represent people’s attitudes toward integrating



P2P payments with social media services.

Our participants highlighted three main sociotechnical barriers that hindered them from using Messenger payment: the established “stickiness” with other digital P2P payment methods, the existing distrust of the Facebook ecosystem, and tensions between money transactions and personal interaction within the same platform.

#### 4.2.1 Sociotechnical Barriers for Using Messenger Payment

Our participants highlighted three main sociotechnical barriers that hindered them from using Messenger payment: the established “stickiness” with other digital P2P payment methods, the existing distrust of the Facebook ecosystem, and tensions between money transaction and personal interaction within the same platform.

##### 4.2.1.1 Established “Stickiness” with Other Competitive P2P Payment Apps

When Facebook entered the already crowded P2P payment market by introducing Messenger payment in 2015, it was still considered a powerful competitor to PayPal or Venmo by mass media [50]. However, the actual users expressed strong reluctance to switch to a new platform due to the so-called app stickiness (i.e., app user engagement that leads to retention and growth; see [89]): as they had already been using other P2P payment apps, they had established their routine interaction circles and expectations for P2P payment services within such apps. In some sense, this form of Messenger payment non-use may result from *displacement* (i.e., displaced use of a similar technology) [195]: the use inertia, as one key determinant of continuance intention [236], offers comfort and reassurance to make users stay with payments apps that they have already been using for a long time.

I3 (man, 22, software engineer) believed that this psychology was prevalent among P2P payment users as it partly reduced the trouble of payment apps mismatch and the peer pressure that may be brought or caused by using new apps: *“I don’t see myself using it unless there’s a lot of people on board.”* I4 (female, 23, student) also shared why it was difficult to switch to a new digital payment product, especially if the new product did not show obvious advantages over existing platforms:

*“I always used Venmo. And Zelle is much more convenient now because you can send money directly to your contacts through your bank instead of adding your bank account*

*info. So I prefer Zelle. In Zelle, you don't need to since it's provided by your bank."*

Meanwhile, the failure to make Messenger payment visible/noticeable to its potential users made it even more impossible to persuade people to switch. For example, a comment on Quora explained,

*"I think one of the main reasons why things like Facebook Messenger and Snapcash have not caught on is a lack of awareness."*

In our study, only one interviewee knew Messenger payment from the news while others found out about this feature accidentally by themselves or were told by friends:

*"As I was chatting with my friend and I talked about sending money, an option popped up to allow me to use messenger payment and also sometimes I mislicked on it."* (I3, man, 22, software engineer)

Apparently, even if the payment function was set to appear automatically at a specific moment for users, it obviously did not draw much awareness and attention. Due to the lack of publicity, it is challenging for Messenger users to realize that the pop-up information indicated the new payment feature. I8 (man, 41, pastor) explained:

*"I think I may have been talking to someone about buying an item. And I saw a little bar saying 'use it to pay'. I ignored it and continued the conversation."*

In this sense, participants who had not experienced the pop-up notification in Messenger constantly complained that the feature of payment was "buried" in the Messenger interface. This made them see no point in taking efforts to use a new P2P payment service if few people could even know or find this feature.

#### **4.2.1.2 Distrust of the Facebook Ecosystem**

Another important barrier was that people just did not trust the Facebook ecosystem. These users were much concerned about Facebook's negative reputation regarding privacy and security risks, especially after several data privacy scandals such as the case of Cambridge Analytica. As a result, participants showed active resistance [195] to the idea of combining Facebook with sensitive

financial information/activities. Instead, they would actively seek alternatives, such as Zelle, a bank-supported P2P payment app. For example, a post on Cyberheist News anticipated the potential privacy and security risks of Messenger payment:

*“This new Facebook payment option could allow several kinds of scams....Also, when a friend messages you and their account has been hacked, there is a criminal trying to scam you impersonating your friend.”*

According to this post, Messenger payment may inherently be subject to the vulnerabilities of the instant messaging app itself. Therefore, a reasonable alternative was to use other specialized professional payment apps. Our interviewees also echoed this concern: I5 (man, 23, student) equaled Messenger payments section to the entire Facebook:

*“I wouldn’t want to put my information, my credit or debit card information into something that is basically FB just out of security reasons.”*

I5 was afraid of using Messenger payment simply because this service was provided by Facebook. For him, his distrust of Facebook, in general, was valid enough to motivate him not to use a digital payment affiliated with it. More importantly, other popular digital P2P platforms such as Zelle partners with leading banks and credit unions, improve their credibility to manage and protect financial activities. In contrast, the lack of a trustworthy financial entity as endorsement and support behind Facebook leads to increasing privacy and security concerns, as I8 said, *“Who is the bank for Facebook, I don’t know.”*

In fact, Messenger payment did provide extra security procedures such as PIN or using facial recognition or fingerprint to confirm transactions. However, regardless of these effective security features, Facebook’s negative publicity in the media has made such security settings less convincing, deepening people’s distrust of Facebook’s products. Many potential users seemed to be already cautious about the Facebook ecosystem, making them reluctant to try any financial services provided within this ecosystem.

#### **4.2.1.3 Tensions between Money Transactions and Personal Interaction**

Another interesting finding was that people considered combining personal money transactions with Messenger, an instant messaging app for personal interaction, quite awkward. As a result, these users were reluctant to use or were only willing to partly use Messenger payment as

disenchantment [195]. A post on Reddit explained that using digital P2P payments through an app that was for chatting and connecting with friends was embarrassing, especially when it came to borrowing money: *“All it’s going to lead to is people I haven’t seen since high school asking me to lend them money.”*

Other comments on Facebook also sarcastically expressed the underlying concerns regarding conveniently integrating financial interactions with social interactions: *“U know my birthday is coming up...”* *“Doug, let me borrow 500 dollars.”* For some users, this awkward combination often leads to negative experiences, as a Facebook comment showed:

*“This is awful. Facebook you are opening a can of worms that will cause a lot of friends to part ways.”*

Therefore, some participants expressed the hope to avoid intertwining social and financial lives. For example, I4 (woman, 23, student) said,

*“I just prefer to talk with friends on it. With payment apps, they’re only for payment.”*

For many people, Facebook is always viewed as a platform to establish or maintain close social relationships (e.g., friends, classmates, alumni, or family members). Messenger makes such social interactions convenient and direct by offering private and immediate one-to-one interpersonal communication. Conducting financial activities such as digital P2P payments in a sociability and communication-centric platform seems inappropriate for them – would an instant messaging app be professional and safe enough to deal with financial activities? How would conducting financial activities through an instant messaging app lead to potential tensions and undesired social consequences (e.g., how to decline a friend’s message to borrow money through Messenger payment)? Therefore, an effective and simplest solution is not to use Messenger payment to avoid potential embarrassment or destruction of friendships.

#### **4.2.2 Diverse Perceptions of Integrating P2P Payments with Social Media**

Obviously, Facebook was not the first to integrate P2P payments with social media services in the world. While Messenger payment’s path to success seems not to be smooth in the USA, WeChat’s P2P payment service has dominated China’s P2P payment market. As integrating P2P

payments with social media becomes an emerging trend for innovating financial technologies/services, it is important to understand people's diverse perceptions of such an integration.

In our study, some participants did hold a more positive attitude towards this trend. A few social media posts described it as “*a brilliant move*” or “*a great advance*” (Facebook comments). I8 (man, 41, pastor) was also impressed by its novelty: “*I think it's a creative idea. And I think many people would probably use it eventually.*” Some others highly praised the convenience of such an integration for everyday life. For example, I6 (man, 22, student) mentioned:

*“It's totally ok to combine social media with payment, right? And maybe this could be even more convenient for us, because lots of our friends or network are already on board.”*

For him, the biggest benefit was his existing social network on the platform (e.g., “*lots of our friends or network are already on board*”). Compared to other digital P2P payment services where users have to manually add recipients, integrating P2P payments with social media takes advantage of a user's existing social network, which would significantly save one's time and energy to establish the financial network. A Reddit post showed similar thoughts:

*“For someone like me who uses Messenger a whole lot for different reasons, it's nice to see all these features.”*

For these users, a comprehensive ecosystem that incorporates diverse functions would provide them with greater convenience – e.g., no need to download standalone apps one by one.

However, some others felt quite overwhelmed by such an all-in-one integration. From the perspective of design, a post on The Verge expressed concerns regarding incorporating excess functions in one platform, which may lead to information overload:

*“I rather see separate apps for these kind of things, mobile apps shouldn't be so bloated.”*

Others also considered this integration “too ambitious” and as a privacy invasion: “*They want to get every piece of info about us!*” (Facebook comment) Especially, a post on Reddit well summarized why people should avoid this trend of all-in-one design:

*“They want to be a part of every single moment of a person's life. [...] They want all your info, everything about your day both online and offline, they want to be your bank, they want... THEY WANT EVERYTHING.”*

In summary, integrating P2P payments with social media appears to be a double-edged sword: while some may find it more convenient by affording all essential everyday social activities (e.g., networking, communication, and paying bills) through a single platform, others express concerns about information overload, higher privacy and security risks, and confusions/tensions between different social functions.

### 4.2.3 Design Suggestions for Motivating People’s Future Use of Digital P2P Payments

Our participants provided specific suggestions to help promote people’s willingness to adopt digital P2P payments in the future. We summarized two main directions they have highlighted. First, for specific digital P2P payment services that are closely related to certain brands such as Facebook Messenger payment, participants believed that reducing public’s distrust in the brand is the key. In this sense, promoting the future use of certain digital P2P payments platforms should go beyond the platform itself but focus on building a positive public image of the company and raising public awareness of this platform by conducting effective marketing strategies, highlighting unique payment features, and so forth. Second, to attract and retain initial users to a new digital P2P payment service, designs for incentives can be used. For example, I6 (man, 22, student) suggested a reward system, *“Like if I could pay stores and accrue rewards points. Or even if I could pay friends and get points. And those points can be used for discounts.”* In doing so, potential new users may be motivated to adopt a new technology like digital P2P payments and continue to use it over time.

## 4.3 Discussion

The findings of Study 1 have shown that: 1) the reasons why people are unwilling to use Messenger payment lie in the established “stickiness” with other digital P2P payment apps, Facebook itself, and the tensions between money transactions and personal interaction; 2) participants in our sample showed diverse perceptions of integrating digital P2P payments with social media including praise for its convenience to afford essential financial and social activities through a single platform, concerns about information overload and privacy/security risks, and confusions regarding different social functions.

### 4.3.1 New Perspectives on Technology Non-Use

Study 1 confirms previous research on the social and cultural reasons for technology non-use [17, 104, 108, 246]. Participants have shown proactive attitudes to refuse to adopt Messenger payment. These proactive attitudes also help shape cultural interpretations of technology as well as eager adopters do [195]. As active resisters, they expressed critical concerns and alternatives toward Messenger payment. Specifically, our results suggest that privacy [216], data misuse [17], and preference for other ways [14] lead to non-use as prior studies concluded.

However, the non-use of Messenger payment is also uniquely intertwined with Facebook as a social media platform. This indicates one's struggles between financial life and social life, which leads to potential non-use. As we have shown, incorporating financial functions with social functions (e.g., social networking and instant messaging) led to tensions between money transactions and personal interactions. This unique combination triggered feelings of awkwardness and embarrassment, which motivated them not to use such a service. Due to the fact that all-in-one design has just become a popular technology trend in recent years, how the integration of different technologies and social functions within one platform/application further extends and complicates technology non-use would be an important question that requires future research.

Consistent with previous studies [41, 45, 136], our findings also show that design plays a crucial role in encouraging or discouraging the use of digital P2P payment services. For example, the design decision to hide the payment feature in the Messenger interface led to poor publicity and low awareness of this service, which resulted in its failure.

Yet, findings of Study 1 reveal that other sociocultural factors beyond design would affect digital P2P payment users' decision-making. This provides new insights on technology non-use in the context of financial technologies. For example, prior studies show that non-users were dissatisfied with the specific technology or service itself. In contrast, in our study, people decided not to use Messenger payment due to their existing privacy and security concerns about Facebook as an ecosystem rather than about Messenger payment itself. Therefore, the social image of the brand or the tech ecosystem itself matters. In the case of Messenger payment, it suffered from a damaged public image of Facebook regarding data privacy breaches and security risks. According to Fu et al., user-perceived security and privacy concerns and their stereotypes often led to the rejection of the chat function in the online payment app Alipay [70]. Similarly, in Study 1, Facebook's damaged

public image invited distrust and security/privacy concerns. It also reinforced the stereotype that using social media to make payment was insecure and troublesome. In this sense, sociocultural factors such as the perceived privacy and security considerations of a technology’s social image led to potential users’ low faith in using its service, even though the technology giant implemented highly advanced security features. Sociocultural factors, therefore, in addition to design patterns, should also be taken into account when developing a sustainable digital payment system.

### 4.3.2 Lessons for All-in-One Design

The sample in Study 1 is relatively small. Yet our participants still provided certain insights that may inform plausible future directions for better approaching and promoting all-in-one design – an increasingly popular trend in technology design that integrates multiple diverse functions within one application.

First, our participants pointed out that an appropriate entry point to guide users to accept and adopt all-in-one design matters. In this case of Messenger payment, incorporating this new digital P2P payment service with social media seemed to be abrupt. It lacked an appropriate presentation of how this design concept could be closely related to users’ everyday lives (e.g., how could Messenger payment be closely tied to users’ daily social activities and interactions with friends?). In contrast, the success of WeChat digital P2P payment may partially lie in its appropriate first introduction - P2P payment as red envelopes (monetary gifting) for the Chinese New Year, which is not only seamlessly interwoven with daily lives but also deeply embedded in the traditional Chinese culture that most users are familiar with [245, 248]. In this sense, framing personal money transactions as “red pocket” through WeChat fits Chinese users’ cultural expectations for financial activities. This helps them embrace the integration of money transactions with social media (as a form of all-in-one design) more comfortably. In contrast, directly gifting money for social events may be generally considered inappropriate in Western cultures. As a result, the “red pocket” model may not work on platforms in the US or other Western cultures. This seems to highlight the importance for designers and developers who engage with all-in-one design to take local cultures into account. For example, marketing strategies for introducing any all-in-one design products should be designed and implemented according to specific local cultures’ values.

Second, all-in-one design appears to be both convenient and comprehensive (e.g., using one platform to access all features/functions needed) for some of our participants. However, it may



trigger unwanted confusion and tensions for some others due to the blurred boundaries between different functionalities (e.g., switching between different features, conducting financial activities while maintaining everyday social networking). Such blurred boundaries often affect users' strategies when coping with various task-oriented functions and thus increase usage workload. This becomes a major challenge for people to accept and adopt all-in-one design.

In Study 1, Facebook Messenger as an instant messaging tool, facilitates frequent and close interpersonal communication. This sometimes makes social interactions too close and too crowded for users [206]. In addition, it is not an ideal environment for financial activities as people tend to be more cautious and prudent when conducting such activities. In this sense, Messenger payment endeavors to host, support, and maintain two different contexts of interactive activities within one platform.

On the one hand, this integration does allow Facebook users to initiate payment behaviors more directly and easily. On the other hand, it also greatly increases the uncertainties, tensions, and confusion. For example, which social norms or regulations should users follow to deal with the intertwined financial/social activities?

As Study 1 has shown, when participants were asked to lend money to those with whom they had weak ties on Messenger, they not only had to make judgments about trust based on one's developed social capital and the platform itself [162] but also were forced to face their own roles in an awkward social relationship (e.g., lending money to build a stronger relationship or not lending to risk a potentially strong relationship). Therefore, it is important for HCI designers to carefully tease out the blurring boundaries of different functionalities, the specific social context of individual functionality, as well as users' diverse needs in order to make future all-in-one designs more acceptable to users.

In general, Study 1 sheds light on the emerging tensions between the increasingly popular computer-mediated money transactions and people's social life as shown in how they are reluctant to use a social digital P2P payment app. However, Study 1 does not explain how and to what extent digital P2P payment technology can affect people's interpersonal activities in various ways, especially in the offline world. Therefore, Study 2 is conducted to provide a rich and in-depth qualitative perspective of how digital P2P payments can influence people's social connections, such as offline interpersonal relationships with known contacts, through semi-structured interviews.

## Chapter 5

# Study 2: The Interplay of Money Transactions and Offline Interpersonal Relationships through Digital P2P Payments

Money transactions between individuals play a critical role in people's interpersonal relationships since money is a sensitive and complex component of everyday life. In particular, emerging digital P2P payment applications further complicate how people deal with each other regarding money. Yet, there is a lack of empirical evidence on how and why such technology may lead to new and more complex influences on people's offline interpersonal relationships. Using 31 in-depth interviews, Study 2 explores the influences of using digital P2P payments on people's experiences of personal financial exchanges and their offline interpersonal relationships. This study focuses on the following questions: (1) How does using digital P2P payments affect people's experiences of personal money transactions with known contacts? (2) How does using digital P2P payments affect people's offline interpersonal relationships?

Findings show that using digital P2P payments helps reduce awkwardness, ensures a stronger sense of fairness, leads to loss of emotion in communication, and increases peer pressure in the

moment. In the long term, using digital P2P payments has the potential to relieve tension and reduce distrust in people’s interpersonal relationships but they also result in decreased emotional attachment to the sender/recipient.

## 5.1 Methodology

### 5.1.1 Data Collection

Due to the exploratory nature of this dissertation research, in-depth semi-structured interviews were conducted in Study 2 to investigate people’s rich and in-depth personal experiences with digital P2P payments. We chose interviews as the study method to be able to obtain more detailed and thorough information from a small number of people [3]. In particular, we used semi-structured interviews to make participants feel at ease and reveal more important and relevant issues [3] to help explain, better understand, and explore their opinions, behavior, and experiences. Moreover, in-depth information collected from interviews would help us to design a large-scale survey for the following study (i.e., Study 3).

To recruit participants, we posted recruitment messages on social media (e.g., Facebook) to recruit interviewees who had used any digital P2P payment apps and who were willing to be interviewed as voluntary participants. A snowball sampling was also used. All respondents who agreed to participate were interviewed. As a result, 31 semi-structured in-depth interviews were conducted via text, call, face-to-face chat or remote video chat based on interviewees’ preferences of modality from February to March 2020 and in December 2021.

Out of the 31 participants, 17 self-reported as women and 14 as men. Participants aged from 18 to 73 years old with an average age of 33.1 years old. 2 self-reported as African American, 10 as Asian (including Indian, Chinese, Korean, Chinese-Thai), 4 as Middle Eastern (including Arab and Persian), 10 as White, and 4 as Hispanic and Latino. The average length of interviews was 36 minutes. Participants also report that they used diverse digital P2P payment apps: Venmo (N=21), Zelle (N=17), PayPal (N=9), Cash App (N=5), WeChat Pay (N=2) Apple Pay (N=2), Google Pay (N=1), Chase QuickPay (N=1), Monzo (N=1) and Bancolumbia App (N=1). Table 5.1 summarizes demographic information of interviewees, popular digital P2P payments apps they used, and experiences/frequency of their use.

In each interview, open-ended questions regarding participants’ financial interaction through

Table 5.1: Demographic information of interviewees

ID	Gender	Age	Country	Self-Reported Ethnicity	Apps	Experience (years)	Frequency
P1	Woman	31	USA	White	PayPal	10	Twice a month
P2	Man	23	USA	White	PayPal	6	3 times a year
P3	Woman	25	USA	Chinese	Venmo	2	Once a month
P4	Man	22	UAE	Persian	WeChat Pay		
P5	Man	24	South Korea	Korean	Venmo, Zelle	4.5	4 times a week
P6	Woman	24	USA	African American	Monzo, Venmo	2	N/A
P7	Woman	25	China	Chinese	Venmo, PayPal	4	Once a week
P8	Man	28	Jordan	Arab	WeChat Pay	6	Everyday
P9	Woman	36	Iran	Persian	Venmo		
P10	Woman	25	China	Chinese	Zelle	1	N/A
P11	Man	43	USA	White	Zelle	1.5	3 times a week
P12	Man	28	Iran	Persian	Chase QuickPay	3.5	Once a month
P13	Man	24	Columbia	Hispanic/Latino	Zelle	N/A	N/A
P14	Woman	24	India	Indian	Venmo, Cash App, Zelle	3	3 times a week
P15	Man	30	USA	White	Bancolumbia App	2	Every 2 weeks
P16	Man	20	Italy	Latino	Zelle, Venmo	2	Once a month
P17	Woman	19	N/A	Latino	Venmo, PayPal	3	3 times a month
P18	Man	20	N/A	Indian	Venmo, Zelle	2	Twice a month
P19	Woman	N/A	N/A	N/A	Venmo, Cash App, Zelle	1	Several times a week
P20	Man	19	N/A	Latino	Apple Pay	2	3 times a week
P21	Woman	18	USA	White	Venmo, Cash App, Zelle	1.5	Every 2 weeks
P22	Man	20	India	Indian	Venmo, Google Pay	1.5	Several times a week
P23	Man	20	India	Indian	Venmo	2	3 times a week
P24	Woman	58	USA	Caucasian	Venmo, Zelle	3	Twice a week
P25	Woman	50	USA	Chinese-Thai	Apple Pay, Zelle	2	Not very often
P26	Woman	46	USA	Caucasian	Venmo, PayPal, Zelle	3	Twice a month
P27	Woman	Baby Boomer	USA	Asian	Venmo, PayPal, Zelle	2	Once a month
P28	Woman	73	USA	Caucasian	Zelle	2	Rarely
P29	Man	72	USA	Caucasian	PayPal, Venmo, Zelle	20	Once a month
P30	Woman	66	USA	African American	PayPal, Venmo, Zelle	20	Once a month
P31	Woman	46	USA	White	Cash App, Venmo	1	Weekly
					Venmo, PayPal	4	Once a month

**Note:** N/A – participants preferred not to answer.

different P2P payment apps, payment habits, and perceptions and experiences of impacts of using these apps on their daily social life were asked (see Appendix B). Examples of interview questions include “Do you think using P2P payment apps is a positive or negative experience for maintaining/building your interpersonal relationship? Why?” “When you use P2P apps, how did you often initiate the transaction process?” Inspired Kim et al.’s research on pettiness in exchanging resources [103] and media coverage on manners and etiquette of P2P payments [214, 240], we also asked ques-

tions such as “*Do you send an exact amount of money or round it via P2P payment apps? Do you pay people the exact number of money or round it in cash? Why do you tend to round it or pay the exact amount of money?*”

### **5.1.2 Data Analysis**

We then used an empirical, in-depth qualitative analysis [217] of the collected data to explore the unique role of using digital P2P payment apps in people’s experiences of interpersonal financial exchanges and interpersonal relationships. A qualitative approach is appropriate in study because qualitative methodologies are well-suited for investigating questions about “how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences” [145]. Similar to Study 1, we did not seek inter-rater reliability in our analysis but endeavored to identify recurring themes of interest, detect relationships among them, and organize them into clusters of more complex and broader themes. In doing so, our analytical procedures were: 1) we closely read through participants’ narratives to acquire a general understanding of the whole picture in regards to how people perceived and experienced P2P payment app in their experiences of interpersonal financial exchanges and interpersonal relationships and identified thematic topics and common features in the data; 2) we carefully examined and reviewed the thematic topics and developed sub-themes; 3) we collaboratively engaged in an iterative coding process to combine and refine themes and sub-themes to generate fundamental aspects and synthesized narratives of how people experienced digital P2P payment apps in their financial exchanges and interpersonal relationships.

## **5.2 Findings**

### **5.2.1 General Usage Patterns**

Regarding sender/recipient, in our study, all participants have used digital P2P payment apps to conduct money transactions with people they know, such as friends, family members, co-workers, landlords, or other acquaintances. Regarding motivations, 74% (N=23) participants started to use digital P2P payments due to its convenience, ease of use, and instantaneity. For instance, several participants highlighted that they were motivated to use digital P2P payment apps because

it saved them from certain inconveniences of using traditional payment options (e.g., need to carry cash or a checkbook): *“I don’t need to bring cash and purse with me. And it’s fast. I don’t need to collect coins.”* (P7, woman, 25, China, Chinese)

*“Part of the reason why I started using the apps was because we weren’t near cities or banks so often. More for convenience, [...] you had to write out a check in three days in the mail.”* P29 (man, 72, USA, Caucasian)

P17 (woman, 19, N/A, Latino) added that using digital P2P payment apps allowed her and her friends to complete transactions immediately to avoid potential financial conflicts:

*“I use the apps to not be in debt with people when they let you borrow money.”*

Additionally, due to the popularity of digital P2P payments, some participants in fact made the decision to use digital P2P payment apps based on their peers and social surroundings. For example, P24 (woman, 58, USA, White), a 58-year-old mother, tried digital P2P payments in hope of keeping up with the era and her young daughter *“I don’t want to be like my mom, where you fall behind.”* Others decided to adopt digital P2P payments because their co-workers or friends asked them to. Furthermore, the security of digital P2P payments attracts some participants to choose it as their main payment option: *“I’ve looked into the security that they use and it seems pretty solid, more solid than some of the other options that I’ve done research into online”* (P2, man, 23, USA, White). Even when some participants preferred cash, they were still willing to adopt digital P2P payments as an alternative when cash was unavailable to them, or especially during the pandemic: *“I’ve had to pay people who I don’t see in person for music lessons”* (P31, woman, 46, USA, White).

Regarding purposes and contexts, participants usually used digital P2P payments when they needed to split bills, ask for/pay reimbursement, split cost with others to purchase a gift together, send money to family members, and so on. Regarding mode, in some cases, they would make digital-P2P-payment-mediated transactions face to face right at the moment. For example, P27 (woman, Baby Boomer, USA, Asian) shared her experience, *“I had to give this person some money. We were chipping in for a present or somebody. And so, I was chipping in. And the easiest way was to send her that money via Zelle.”* According to P27, digital P2P payments can be used like cash to get people to immediately engage in payment-related social occasions. If participants were not available to make transactions in the moment, they tended to complete the transactions asynchronously but still in a timely manner. P24 (woman, 58, USA, White) described, *“There was a time when we did a group gift, we were going away. So one lady said, ‘I’ll collect all the money.’ So she sent*

out an email message, and then you replied through it. So I just use Zelle, which she got it right away.” In this sense, digital P2P payments allow users to make money transactions face to face as well as remotely depending on the specific social contexts and occasions; and users can decide if they would like to complete the transactions synchronously or asynchronously based on their own needs/situations.

## **5.2.2 How Digital P2P Payments Influence Offline Interpersonal Relationships**

Using quotes from participants’ own accounts, we further present our findings about influences of digital P2P payments as two parts: immediate consequences of money transactions through digital P2P payments; and last impacts through the use of digital P2P payments on dimensions of offline interpersonal relationships.

### **5.2.2.1 Immediate Consequences of Digital-P2P-Mediated Money Transactions**

Overall, participants believed that their relationships with their known contacts had been directly influenced by digital P2P payment apps. They highlight four main immediate consequences of money transactions via digital P2P payments in the moment: reduced awkwardness when managing money with people they knew; a stronger sense of fairness when dealing with paying with known people; increased peer pressure if asked to use digital P2P payments by known people; and lacking emotion in communication when making digital-P2P-mediated money transactions with people they knew.

#### **5.2.2.2 Reduced Awkwardness**

Personal money transactions such as splitting bills, paying rent, and transferring tickets are now prevalent in people’s everyday lives. Yet, these exchanges sometimes cause unwanted awkwardness and potential embarrassment among relatives and friends. One of the typical scenarios is that when splitting bills, one pays for all first and then others should pay back to him/her later but forget to do so. For example, P13 (man, 24, Columbia, Hispanic/Latino) described: *“Usually people remember paying in the near future but not always and it is awkward to ask for that.”* In this case, people who pay for the bill often face a dilemma: whether the other party intentionally or unin-

tentionally forget to pay them back, they may either lose their money unwillingly or cast shadows on their friendship by insisting on asking for their money back. Using digital P2P payments, thus, is considered by many participants an effective solution to reduce awkwardness and embarrassment when dealing with money with relatives or friends in three ways.

First, it is instant and convenient without time lag. P17 (woman, 19, N/A, Latino) and P8 (man, 28, Jordan, Persian) both pointed out:

*“All you have to do is to search up the person, type the amount, do a caption if you want and then send. And it’s really, really easy. Because of how easy and quick it is, this makes me skeptical of people who claim to take a while to pay someone back.”* (P17)

*“I think it makes hangouts more friendly, for example when we finish dinner everyone can pay very quickly without having to stress. It makes splitting the bill easier. For me I don’t feel comfortable asking for money back especially when less than \$10.”* (P8)

For P17 and P8, using digital P2P payment apps created positive experiences of interpersonal financial exchanges because all parties who involved in casual payments (e.g., splitting a dinner bill) could make an instant transaction at the moment without any excuses. This significantly reduces or even avoids the potential embarrassment of having to discuss finances, such as splitting bills and explicitly requesting money transactions (e.g., asking for repayment after some time or asking for a small amount of money back), especially with people whom they knew.

Second, the electronization of digital P2P payments offers a less personal and more neutral way to communicate finance-related information (e.g., to ask money back), which helps reduce the sense of embarrassment. For instance, P24 (woman, 58, USA, Caucasian) pointed out that the traditional way to discuss finance-related details is awkward, especially in front of a bunch of people,

*“Having a real big bang at the end of this year, and everybody’s supposed to be collecting money for pizza and pop. Going after everybody for their \$5 for the pizzas, is kind of embarrassing. Especially the cash is awkward. Or people like, ‘Do you round up?’ Or ‘Do you give the exact amount?’ So it’s kind of awkward because other people are kind of looking to see what you’re doing. So being able just to send a note to 5 or 10 people, ‘Hey, you owe me this much’, I think will be easier.”* (P24)

It can be challenging to initiate conversations about money especially in social events. Digital P2P payments could make finance-related behaviors more private, less personal, but more



natural. In this sense, people do not have to dwell on communicating finance-related information too much in public to get their money.

P19 (woman, N/A, N/A, N/A) and P23 (man, 20, India, Indian) also shared,

*“It might be awkward to call up somebody and say ‘Hey! Send me my money!’, but it’s easy to send a little cash reminder through the application. You never have to talk to them. There’s no awkward tone in your voice. It’s just an electronic reminder.”* (P19)

*“It’s a positive influence into building relationships because there’s no boundaries or walls to not ask for money back anymore [...] Now, with Venmo with a click of a button, they can just send you your money like that. There’s no reason the transaction be delayed.”*

(P23)

In both P19’s and P23’s stories, digital P2P payments made money transactions between people less awkward because it reduced interpersonal communication as much as possible – e.g., no need to have face-to-face or voice chat but just click a button through an app. In this sense, money transactions seem to be somehow separated from interpersonal interaction, thus reducing the potential impacts of sensitive feelings about money and the transactions on interpersonal relationships.

Third, as a type of electronic money transfers, digital P2P payment apps allow users to look up their transaction records easily and quickly, especially compared to using cash as P25 (woman, 50, USA, Chinese-Thai) mentioned, *“I can just look on my phone. I look on the app and said ‘Oh, yes, Sally Venmo me \$25.’ It’s like all there. [...] In the old days, you pay cash. You got to write a receipt.”* Likewise, in P3’s (woman, 25, USA, Chinese) opinion, this affordance led to positive financial experiences, especially when family and friends often took turns to pay: *“We don’t have to keep track of who owes who.”* P10 (woman, 25, China, Chinese) also added: *“The clear records help avoid money troubles.”* In this sense, an extra benefit of using digital P2P payments for managing personal money transactions is to automatically document the amount, time, and other related information of a certain money transaction. With such evidence, it is less likely for different parties to engage in arguments and disputes over everyday money transactions, which would prevent potential awkwardness and embarrassment.

### 5.2.2.3 A Stronger Sense of Perceived Fairness

Another reason why participants found the use of digital P2P payments positive was a stronger sense of perceived fairness in their money transactions compared to traditional face-to-face transactions - e.g., the money transactions are more accurate, the cost-sharing is more effective, and people are less likely to be taken advantage of. For example, P3 (woman, 25, USA, Chinese) explained that it was challenging to ensure fairness in traditional face-to-face transactions, which often required tremendous efforts and certain strategies:

*“Me and my friends have sort of a tacit understanding to split the bill. I pay for a meal, they can buy me boba [...] So it’s boba plus dessert to make up for my meal, or if we’re going to watch a movie later, they pay for the ticket.”*

As P3 suggested, in order to make everyone pay their fair share, friends often had to navigate through costs of different events and estimate an average final payment. This process was often time-consuming and subjective, which may be subject to arguments and disputes. In addition, P24 (woman, 58, USA, Caucasian) pointed out that the inconvenience of cash makes people more likely to round the amount, which may cost the payer extra money,

*“So it’s embarrassing to have to say, ‘Hey, you didn’t give me that’ in front of a bunch of people. So you probably wouldn’t say anything. You just throw your own money. [...] If it’s 5.95, and everybody just gives you five, there was a group of 10 people, guess what, you’re \$10 short. Then you’re going to tip money. And then if you’re not able to tip the server, then you’re using your own money. Back in the day, that’s probably another reason why nobody wanted to take care of the bill because every time they do it, they get shorted!”*

According to P24’s explanation, for group payments, people are not only ashamed to ask others for the money they are owed, but also very likely to use their own money to make up for the shortage caused by round cash, including some extra costs (e.g., tips). Such double troubles and obvious unfairness make some people try to avoid from being the volunteer to pay group bills first. Therefore, P13 (man, 24, Columbia, Hispanic/Latino) believed that using P2P payments helped achieve fairness in personal money transactions easily:

*“I always try to be fair with money issues and have an easy way to pay others and get paid, which is very good to avoid worrying about fulfilling obligations.”*

According to him, digital P2P payments provided a precise and fast way to transfer money with few physical restrictions. This helped him fulfill his obligations in money transactions with little effort – he would not worry too much about nervously waiting for others to repay nor feel sorry about forgetting to repay others in time. In particular, P11 (man, 43, USA, White) believed that with exposing shirkers and leaving few places for people to hide, using digital P2P payments would significantly reduce the psychological and social pressure on the very one person under some circumstances:

*“Using P2P could be better for me because I rarely have cash in my wallet. So I’m usually the guy that puts on the card and everyone pays me back. Now thinking about it from that standpoint, so having P2P payment, if everyone else uses the same one, is nice. It takes the pressure off that I don’t have to be the one to do it.”*

For P11, the greatest benefit of using digital P2P payments was to avoid the burden and stress of paying the bill for everyone and then chasing people to pay him back. As P11 noted, it was often a stressful experience for him to hang out with friends because he was always asked to pay for the entire bill first via card. The rationale was that he did not carry cash and thus could not repay others at the moment. With digital P2P payments, he no longer needed to shoulder this responsibility simply because of his own personal preference to handle money (e.g., carrying cash or not). Therefore, for P11, this was a fair way to track and manage financial exchanges with multiple people: no one would bear the financial responsibility or owe anyone money.

However, participants also commented that the endeavor to make excessively precise and fair transactions might lead to a feeling of pettiness, which may negatively affect their experiences of financial exchanges. For example, P4 (man, 22, UAE, Persian) explained:

*“It gets annoying when people are super super precise, like if we buy a \$3 snack and everyone shares [...] this looks a little bit petty. It gets too annoying at that point.”*

According to him, the ability to conveniently transfer precise payment was definitely a benefit of using digital P2P payments positively. Yet the overemphasis on precise or fair payment can be counteractive - making the experiences of financial exchanges negative and “annoying.” In

this sense, absolute fairness in financial exchanges may actually make people feel less comfortable. This may even eventually affect their offline interpersonal relationships.

#### 5.2.2.4 Increased Peer Pressure

Despite the above-mentioned benefits for people’s social lives, digital P2P payments also pose challenges for people’s offline interpersonal relationships. One example is the heightened peer pressure. For example, a prerequisite for both parties to use digital P2P payments is to download the same P2P payment app. This sometimes increases peer pressure on using smartphones, downloading apps, and being open to online payments. P2 (man, 23, USA, White) reflected such conflicts between his preferences of payment and the current social trend:

*“I dislike P2P payments compared to cash. I’m a bit archaic. I have no social media. I didn’t grow up with WiFi. I don’t have that on my phone. So there’s a lot of those things that some people consider normal for the 21st century that I do not do. So it probably goes in the same hand and causes issues when everyone wants to do digital P2P payment but I just cannot.”*

However, the increasing popularity of digital P2P payments inevitably makes people face frequent requests for using digital P2P payments from acquaintances, friends, family, or colleagues when personal money transactions are needed. This thus “forces” them to start using such apps regardless of their own willingness. P30 (woman, 66, USA, African American) shared such an experience: even though she was 66 years old, she had to start using certain digital P2P payments apps because all people around her had the apps and asked her to use them as well,

*“I’ve had to get Venmo because in my job, if we’re buying gifts, and somebody is asking for donations towards gifts for our staff people, they have Venmo or Cash App. I put Venmo on recently because the people that were collecting the money all have Venmo.”*

For P30, the common expectation of “all have Venmo” makes her feel peer pressure to start using digital P2P payments, though she was not familiar with such platforms and were reluctant to use them in the beginning. Although many older adults did acknowledge how easy and convenient digital P2P payments could be, this age group still struggled with the on-boarding process to some degree, as P28 (73, woman, USA, Caucasian) pointed out, *“It’s a little daunting, trying to go through the steps to get it started and get it up.”*

Even for younger users, it was not always easy to decide to use digital P2P payments. P15 (man, 30, USA, White) shared his story,

*“When my friend asked me to use the app to transfer money, there was a little social friction because I didn’t have the app. I wasn’t really comfortable downloading the app just for this one transaction. I didn’t understand the utility of having the app long term. I didn’t want to give someone my bank account information. I eventually did it for my friend but it was not a good experience.”*

According to P15, he only downloaded and used the digital P2P payment app because his friend asked him to. From his perspective, digital P2P apps are more like one-time use. It is not worth the effort to download and to shoulder the risk of providing highly private and important information such as bank information. Therefore, he felt being forced to give out his own preference and privacy (e.g., bank accounts) in the moment when his friend asked, which might negatively affect his friendship.

Even when participants were indeed comfortable with using digital P2P payments, they mentioned the challenges to navigate through various digital P2P payment services, as P25 (woman, 50, USA, Chinese-Thai) shared,

*“I felt with one of my friends that they use Zelle, and I was thinking in my head, why can’t she just download Venmo? Because I have Venmo, I don’t have Zelle. But she was like ‘No, no, I only have Zelle.’ So then finally I had to download it. so that’s a kind of pressure.”*

As people cannot transfer money between Venmo and Zelle directly, users like P25 have to reach an agreement with each other to use the same platform. In P25’s case, she made a compromise to download another app to make the transactions with her friends. For them, although various digital P2P payment apps exist on the market, choosing which one to use is not completely their own decision but subjects to peer pressure (e.g., which one is used by most friends in their social group).

#### **5.2.2.5 Lacking Emotion in Communication**

Traditional payment methods such as cash transactions often involve face-to-face interaction and potentially more personal communication in addition to the transaction itself. Digital P2P

payments, as a computer-mediated payment method, allow users to conduct money transactions remotely without limitation of time and space but eliminate such personal interaction and communication. As P1 (woman, 31, USA, White) and P18 (man, 20, N/A, Indian) pointed out, it *“loses the personal touch of the face-to-face”* (P1) and *“takes out the factor to talk with the community or with other people”* (P18). P1 was also worried that digital P2P payments tended to purely focus on the money transaction itself but lose rich sociocultural information embedded in the transaction:

*“We wouldn’t know the context of the transaction, the pressure of what’s going on, what’s the need, and what’s the reason why I’m giving them money or receiving the money.”*

For P1, exchanging money could also be a potential way to build relationships with people she cared about. Though digital P2P payments are much faster and more convenient, such methods do not facilitate communication and interaction surrounding the behavior of money transactions itself. In contrast, traditional payment methods such as face-to-face cash transactions often provide room for more personal and emotional communication – e.g., for people involved to share their experience and express their feelings. For users like P1, a money transaction is more than a simple money transaction but an opportunity to reinforce a relationship and deepen emotional attachment.

Some participants even noted that digital P2P payments made the experiences of personal money transactions meaningless. P1 (woman, 31, USA, White) and P16 (man, 20, Italy, Latino) described,

*“To me, giving someone money in person is more personal and it means more when someone hands me a hundred dollar bill. It’s going to mean a lot more versus someone’s sending me a message: Hey, someone’s giving you money on your PayPal account [...] It’s going to be more meaningful to me because they took time out of their day to hand me the cash. So I probably won’t ever stop doing cash face to face if I can.”* (P1)

*“But if you just Venmo someone, if you’re looking at a screen and a number changes, you don’t appreciate getting paid back as much.”* (P16)

Both participants mentioned the important feelings of attachment, care, gratitude, attention, and even a sense of ritual associated with face-to-face money transactions. For them, money transactions were socially meaningful not because of money itself but due to the emotions and close personal interactions involved in the process of such transactions. This emotional self-expression

made their money transactions less business-like and more personal, sincere, and earnest, which promoted mutual respect, understanding, and empathy in their relationships with known contacts in the long term.

However, the formalization and standardization of digital P2P payments do not afford such feelings for both parties, thus hindering the emergence and development of more personalized and emotional relationships. P15 (man, 30, USA, White) explained:

*“I like when my people who owe me money know that I’m not happy about it. [...] I think having that process be automated, the enforcement of the payment, the automated kind of would create a diffusion of responsibility. Now people are ignoring the system instead of me, but it’s affecting me.”*

According to P15, while creating convenience, digital P2P payments removed the human component from the human-centered money transactions - for example, sending automated standard reminder messages rather than interacting with real human beings. For him, this not only made people less responsible but also sacrificed the valuable contextual cues and emotional expression when conducting money transactions with others.

### **5.2.3 Lasting Impacts through the Use of Digital P2P Payments on Offline Interpersonal Relationships**

Digital P2P payments not only shape people’s social interaction dynamics in the moment but also exert profound influences on their offline interpersonal relationships in the long term. For example, using digital P2P payments may help build trust among friends, relieves tensions in close relationships with known contacts, and de(in)creases the emotional attachment to people they know.

#### **5.2.3.1 Promoting Trust**

Many participants highlighted how using digital P2P payments benefited their social lives by promoting trust between friends due to its affordance of instant money transactions. For example, P20 (man, 19, N/A, Latino) noted,

*“I feel like it makes me closer to my friends because I don’t have to worry about paying them back since it is instant. So there is more trust. It’s like a guarantee right*

*there. You know they paid you or they know you paid them. There is no interference or misconnection.”*

For P20, digital P2P payments made him more confident about his connections with his friends - all transactions were instant and recorded in the system, which left no room for arguments or misunderstandings. In this way, people become closer because they can effectively avoid awkward experiences of financial exchanges, which naturally builds trust and promotes their friendship.

In addition, P9 (woman, 36, Iran, Persian) explained that how using digital P2P payments helped her maintain her existing friendships:

*“By using digital P2P payment, I won’t forget to pay and my friends won’t be upset about me. But if I need to pay in cash, I have to remember it and maybe I will forget. I don’t mean that I don’t want to pay but sometimes I just forget. So in this way, P2P payment helps to maintain the relationship.”*

According to P9, a significant benefit of digital P2P payments was to reduce the potential distrust (e.g., forgetting to pay) and cognitive load (e.g., remembering to pay) when dealing with money with friends. This makes it easier to build and foster friendships – both parties involved can maintain a healthy, positive, and sustainable attitude towards a traditionally sensitive topic - money transactions between friends.

In this sense, the immediacy and convenience of digital P2P payments seem to effectively prevent the emergence and growth of distrust due to intentionally or unintentionally delayed or forgotten payments in people’s social interactions. P8 (man, 28, Jordan, Arab) and P4 (man, 22, UAE, Persian) summarized:

*“I don’t like to keep hanging out with people who don’t pay back, so having P2P will leave no excuse.” (P8)*

*“If I keep reminding [my friends] but they keep forgetting, it will get very annoying to ask them to give the money back. This will make me trust them less. So the digital payment apps solve this problem pretty well.” (P4)*

For both P8 and P4, both waiting for others to pay them back or constantly “annoying” friends to repay their money would undermine the credibility and sincerity of a friendship. Unless the Internet or their digital devices fail, digital P2P payments make it difficult for people to refuse



the request to solve financial exchanges at the moment. As such, digital P2P payments create convenience for money transactions and thus curb the possibility of distrust caused by money in interpersonal relationships.

### **5.2.3.2 Relieving Potential Tensions in Interpersonal Relationships.**

As we mentioned earlier in the study, all participants used digital P2P payments to conduct money transactions with people they already knew. Despite their established interpersonal relationships (e.g., friends or family members), dealing with money may still cause potential tensions. P4 (man, 22, UAE, Persian) shared an example:

*“People usually round it down when they use cash, which can be annoying. If they don’t do it a lot then it’s fine. But I don’t hang out with people who consistently give \$5 instead of \$7.”*

For participants like P4, traditional payment methods such as cash, in fact, introduced unnecessary tensions to their interpersonal relationships: some tend to round the payment down all the time in the name of trying to pay in cash easily, which makes people like P4 feel being taken advantage of. While normally the amount is small, some consider this attitude unacceptable and offensive. In contrast, digital P2P payments make money transactions smoother and more accurate (e.g., paying the exact amount easily rather than rounding it down), thus relieving potential tensions and negative impacts on one’s offline interpersonal relationships. P14 (woman, 24, India, Indian) shared,

*“I think it’s a positive experience for maintaining relationships! Because as young people, we are low on money and would like to get it immediately before people forget! We want to keep our friendships as well.”*

P14 did not want to ruin her friendship because of money. For her, using digital P2P payments effectively loosened both the stress on tight finance and social pressure on maintaining a friendship. Such financial pressure may even make people feel more anxious about socializing with their friends. Using digital P2P payments helped her effectively avoid the behavior of asking for money back, which was likely to create embarrassment and even confrontation in a close relationship. P3 (woman, 25, USA, Chinese) echoed this opinion:

*“Using P2P apps is more positive to my relationships with others. I guess it’s just like a ‘I owe you/ you owe me’ list that gets resolved ASAP, which is nice cuz after time, sometimes we forget who owes who.”*

P3 believed that digital P2P payments allowed people to focus on social activities and interactions that foster friendships rather than being too concerned about money issues. For her, only focusing on money inevitably distracted people from actually spending time and interacting with friends, which might eventually damage the established relationships. P28 (woman, 73, USA, Caucasian) further explained,

*“I think it makes people calm. They know that they’re getting what they need right now. So I think it takes away some of the stress and some of the what ifs. It takes away all of that. There’s no more questions. You see it, you sent it, they see it. And it’s done right now.”*

According to P28, people got the sense of assurance from digital-P2P-payment-mediated transactions as people were able to confirm what they cared about and leave unnecessary suspicion and tensions out. In doing so, people can be more calm and comfortable in interacting with others, which contributes to a healthier, more sustainable, and less stressful relationship.

In addition, P11 (man, 43, USA, White) pointed out that compared to cash, digital P2P payments helped avoid making negative first impressions and conversations about money when initiating and developing a new relationship:

*“For example, some new friends and I went out to dinner. They paid and I didn’t have cash with me and I forgot to pay them back cuz I was busy. They may bother me and have to ask ‘Hey, do you have money? You owe me.’ This may have a negative impact on our new friendship. I think it could be awkward. I think using digital P2P payments is beneficial especially at the beginning of a friendship.”*

According to P11, using digital P2P payments was not only useful for maintaining established relationships but also effective for building a new relationship by making a better first impression. For him, active and timely payment avoided possible awkward scenes that might make people unwilling to further develop friendships. It also served as a valuable foundation to evaluate a promising new friendship.

### 5.2.3.3 Weaken the Emotional Attachment to the Sender/Recipient?

As digital P2P payments may eliminate personal interaction and communication during the transaction process, a concern emerges among some participants that over-relying on the computer-mediated payment method may reduce the feelings of closeness or affection, which weakens the ability to sustain meaningful relationships over time. For example, P31 (woman, 46, USA, White) explained,

*“You aren’t communicating with the others. You’re just kind of sending stuff back and forth. But you may not always have that personal connection. It just becomes a transaction.”*

In P31’s opinion, the instantaneity and electronization of digital P2P payments failed to assume the same underlying and essential functions of personal communication as those when people use cash to make money transactions with known contacts. She highlighted that digital P2P payments would be more business-like without personal communication and emotion involved. P27 (woman, Baby Boomer, USA, Asian) further detailed,

*“It’s like when you were little, your parents, your grandparents, they hand you, you say Happy New Year and whatever and then they can give you the physical red envelopes with cash in it. Now, if you send it electronically, it’s just kind of like, you lose the whole interpersonal interaction.”*

P27 highlighted that money transactions, gift money for instance, were not only transferring money but also a way to exchange emotion, to show love, care and support, to strengthen the existing relationships, and to experience the shared culture. When digital P2P payments speed up, simplify, and even replace this process to share emotions, personal money transactions may lose the deep meanings and implications embedded in them. P24 (woman, 58, USA, Caucasian) further explained that it would be more important to seize opportunities to reinforce connections for those individuals who often cannot meet in person,

*“I think you lose that chance to reconnect. And for people you’re really close to, you see them all the time or family. It’s really convenient and awesome cuz you’re gonna talk to them and go see them anyway.”*

According to P24, when people conduct money transactions offline, they are able to stay in touch and maintain their relationships through conducting these financial activities face to face. In contrast, the use digital P2P payments directly skip the procedure of face-to-face personal communication, which makes people lose the opportunities they could have used to reconnect with people offline and further weaken their emotional attachment to each other.

Some participants contended that digital P2P payments, however, could still facilitate maintaining long-distance relationships and emotional attachment. P26 (woman, 46, USA, Caucasian) detailed,

*“I can send my sister money \$200 in the past. I was like, how do I do that? I don’t want to put \$200 cash in the mail and she lives in a different state than me. So now, I can just do it.”*

P26 highlighted that digital P2P payments made it easier for her to send money to her family members beyond geographical limits so that she was able to show her care and support anytime and anywhere. While there was less emotion and social cues than in face-to-face offline communication, digital P2P payments with text and emojis memo at least made her distant relatives feel supported by her. To some extent, using digital P2P payments may be beneficial for maintaining and strengthening emotional attachment in weak social ties or distant relationships.

### 5.3 Discussion

Study 2 yields two highlights. First, digital P2P payments can directly affect people’s social interactions in the moment: reducing awkwardness, strengthening the perceived fairness to facilitate positive experiences of money transactions, losing emotion in communication, and increasing peer pressure. Second, digital P2P payments also exert several lasting impacts on people’s offline interpersonal relationships in the long term: they promote trust and relieve potential tensions but may also weaken emotional attachment to senders/recipients.

In this section, we discuss how our findings contribute to the existing literature on technology-mediated money transactions and interpersonal relationships. We also propose potential design implications for designers and developers to design more supportive and socially satisfactory digital P2P payment platforms in the future by taking the interplay of financial exchanges and interpersonal relationships into consideration.

### 5.3.1 Nuances of Technology-Mediated Money Transactions in Existing Interpersonal Relationships

Digital P2P payments inherit the features of modern web and mobile technologies: they simplify the process of traditional ways of payment and support remote operation at any time. In Study 2, participants took advantage of these characteristics to make precise, fair, and instant money transactions. This is consistent with findings in previous literature on the usefulness and easiness of mobile payment [87, 256]. However, findings of Study 2 also highlight the nuances of today's technology-mediated money transactions in existing interpersonal relationships.

First, the instant and smartphone-based digital P2P payments make interpersonal conversations and communication in traditional physical activities of money transactions no longer necessary. This tendency is in direct response to an emerging modern financial lifestyle: saving efforts and time as well as avoiding social pressure to manage interpersonal money transactions. In this sense, technology increases the ease of forming friendships around common cultural interests [171]. For example, existing research has found that on social occasions, it is important to check if everyone has a payment app that they are comfortable using and ask people to articulate exactly when they want to be paid back – the so-called “Frientimacy” [159]. In this way, digital P2P payments may reduce awkwardness and increase the sense of fairness in people's experiences of modern money transactions. As our findings show, the overall positive experiences mediated by digital P2P payments align with previous study's emphasis on the comfortable social distance without seeming rude or uncongenial but still supporting a sense of friendly connection [109]. Our participants even considered such experiences more positive than traditional face-to-face money transactions. Further, the reduced awkwardness and increased sense of fairness from financial actions between individuals may help lay the foundation for trust and respect in building and maintaining friendships.

Second, digital P2P payments also reveal several challenges emerging in today's technology-mediated money transactions in existing interpersonal relationships. For the younger generation, they are worried about which apps they have to download per their peers' preferences and requests. Most digital P2P payment systems are not compatible with each other, which can create cumbersome procedures and great inconvenience for people. In addition, as Cham et al. point out, functional (i.e., perceived complexity), psychological (i.e., lack of trust, technological anxiety), and risk barriers (i.e., privacy risk, security risk and financial risk) are significant in influencing the older adults' resistance

to mobile payment services [42]. For older adults, they not only have to face a sharp learning curve to adopt this new type of technology but also find it difficult to trust the digital method to make P2P payments between individuals. For example, the requirement for linking one’s bank account and private information to a third-party P2P payment app clearly raises older adults’ concerns over personal security and privacy risks. These concerns thus increase the peer pressure people may face when using digital P2P payments to make personal money transactions, which could create more interpersonal tensions between known contacts.

Obviously, when people’s payment habits shift from cards or cash to digital P2P payments, how people conduct, manage, and experience money transactions is also changing, which involves the reconstruction of payment scenarios, methods, and social networks. In this sense, advanced financial technology such as digital P2P payments not only makes personal money transactions more convenient and instant but also increasingly plays a unique role in how people perceive, build, and approach their relationships with each other.

### **5.3.2 Design Implications for Supporting Interpersonal Relationships through Digital P2P Payments**

There has been a trend towards combining social networking with payment: Facebook Messenger Pay, WeChat Pay, Venmo’s transaction feeds, and so forth. Such an integration raises privacy concerns as well as points to important questions when developing future financial technology: to what degree should designers and developers take aspects of interpersonal relationships and emotional expressions into account in addition to developing more secure and convenient payment methods? And would such deep and direct integration lead to greater social pressure, especially considering the sensitivity of money in interpersonal relationships?

With these considerations and grounded in our findings, we propose the following suggestions for designing future digital P2P payments. We suggest that designers and developers of future digital P2P payments should take possible peer pressure and avoidance of awkwardness into consideration to help people better manage the interplay of money transactions and offline interpersonal relationships when using P2P payments.

**Making Transactions Process Smoother and More Flexible.** In the study, participants benefited from using digital P2P payments to share bills and clear transaction records. In this

sense, step-up designs about split-wise features, are needed for further streamlining the process to offer more flexibility and convenience. For example, an easier way should be designed to add people into the finance-related discussion or split-bill process such as scanning QR codes via mobile devices; an summary of transaction record can be provided to remind users of the transaction pattern with others; the ability of sending the jointly participated event to ask all involved ones to contribute to the shared bill can be also included in the group payment function.

**The Ability to Send Direct Messages via P2P Payment Apps.** Our findings highlight the less personal and more neutral way digital P2P payments offer when communicating finance-related information. Yet our study also reveals increased peer pressure to use P2P payments, such as downloading the same apps. Therefore, we suggest that users should be able to send mobile phone messages via P2P payment apps to prompt people who owe them. In this way, people who need to pay money back do not need to download the same app but will still receive the reminder of the requested payment. Since the reminder will come through the app instead of users themselves, it may tone down the awkwardness in situations where people need to request money from others.

**Taking Local Cultural Values Regarding Money Transactions into Account.** Our findings also point out that some people were reluctant to use digital P2P payments due to the tensions between one's preferences of how to exchange money and the current trend of using financial technologies, leading to uncomfortable peer pressure on using P2P payments. Therefore, local cultural values regarding money transactions should be taken into account to serve as an appropriate entry point to invite people to accept P2P payments better. For example, the success of WeChat P2P payment may partially lie in its appropriate first introduction - P2P payment as red envelopes (monetary gifting) for the Chinese New Year, which is not only seamlessly interwoven with daily lives but also deeply embedded in the traditional Chinese culture that most users are familiar with [245, 248]. As a result, WeChat Pay not only becomes the most popular digital P2P Payment app in China but also serves as an important way to socialize and build interpersonal relationships (e.g., by gifting each other money). Therefore, making P2P payment apps fit target users' cultural expectations for financial exchanges should be a critical direction for future design and marketing strategies.

**Framing Money Transactions as Social Experiences.** Our findings show that people were concerned about the lack of emotion in current digital P2P payments. The specific personal feelings or emotion should be conveyed to the sender or recipient to make both parties have a shared

awareness about the transaction. Therefore, we suggest providing an option of framing a money transaction more as a social experience (e.g., adding a context of the transaction; associating the transaction with the particular social event as valuable memories such as birthday parties) and less as a business-like transaction. Specifically, the original memo function can be expanded to the internal chat channel/room so that memo or note will not be required for each transaction. Instead, users are able to communicate more in the chat room. In addition, the memo function should include multimedia input including audio, gifs, pictures, videos, emojis, Bitmojis, and so forth to allow users to express their emotion in various ways.

**Reducing Concerns and Barriers for Adopting Digital P2P Payments.** Our findings point out that some people experience peer pressure when making personal money transactions through digital P2P payments. Above all, it requires personal time and efforts to download a certain app that the majority of the social group uses. Therefore, we believe that cross-platform secure P2P payment services would be necessary to ensure the interoperability among various digital P2P payments. For example, a hub of digital P2P payment apps or a centralized digital P2P payment app can be created so that people do not have to download various apps that their different friend groups may require. Additionally, people who are not familiar with the essentials of digital P2P payments may become too concerned about the reliability and security of using such services. We thus suggest making digital P2P payment services more inclusive and accessible for a broader user group with diverse backgrounds and experiences with digital payment methods, such as enabling both mobile and web version services and providing options to not to link bank accounts.

Study 2 unveils how the use of digital P2P payments influences people's offline interpersonal relationships with people they already know both positively and negatively, both in the moment and in the long term. However, it is unclear how these immediate consequences and lasting impacts are related to each other and why using digital P2P payment apps yield different social experiences of money transactions between known contacts compared to the traditional and most commonly used payment option - physical money (i.e., cash). Therefore, Study 3 explores the association between the immediate consequences and lasting impacts of using digital P2P payments and how and why the differences between using digital P2P payments versus physical money (i.e., cash) occur through a large-scale survey.



## Chapter 6

# Study 3: Different Impacts of Digital P2P Payments vs. Physical Money on Offline Relationships with Known Contacts

Study 1 and Study 2 provide rich qualitative findings, which motivate Study 3 to further investigate how immediate social consequences and lasting impacts of using digital P2P payments are related to each other and why using digital P2P payment apps can yield different social experiences of money transactions between known contacts compared to the traditional and most commonly used payment option - physical money (i.e., cash). Through an online survey study (N=218), in the Study 3, we provide empirical evidence of several significant differences between using digital P2P payments versus traditional payment methods (i.e., physical money) in terms of immediate social consequences of such transactions, lasting impacts on people's interpersonal relationships, and perceived usability of the given payment method. We also present respondents' own recommendations to design future digital P2P payments for promoting social connections.

Study 3 has two foci: (1) How, if at all, do using digital P2P payments and using traditional physical money (i.e., cash) for money transactions between known contacts lead to different *imme-*

*diate social consequences* (e.g., perceived awkwardness of the money transaction), *lasting impacts* (e.g., emotional attachment) on people’s offline interpersonal relationships, and *perceived usability* of the given payment method? and (2) How and why do such differences occur?

Through Study 3, we expand the growing research agenda in HCI and HCC on the impacts of new financial technologies and technology-mediated money transactions on people’s everyday lives by (1) highlighting the importance of technology-supported strategies to better deal with money in interpersonal relationships, (2) understanding the trade-offs between reducing interpersonal conflicts and distancing interpersonal closeness via digital P2P Payments. We also summarize important high-level directions by reflecting on respondents’ specific design suggestions for designing more supportive and socially satisfactory digital P2P payment platforms in the future by taking the interplay of financial exchanges and interpersonal relationships into consideration. Findings from Study 3 also inform Study 4, which takes a research through design approach [258, 259] to further advance our knowledge and understanding of how digital P2P payments systems can be redesigned to better support people’s social connections with individuals they know by leveraging participatory design (PD) activities [196, 211].

## 6.1 Theoretical Model & Research Hypotheses

We develop our research framework and hypotheses by adapting the classic and well-established technology adoption model (TAM). We use this model to orient our research because it helps to understand critical factors that contribute to people’s intention to actually use a new technology (e.g., digital P2P payments) and can be used to predict the (future) use intention of such a technology as well. We also ground our framework and hypotheses in the existing literature on social aspects of digital P2P payments services [2, 83, 98, 220, 227] and our prior work on two critical aspects of social influences of using digital P2P payments (i.e., immediate social consequences and lasting impacts on interpersonal relationships) [118].

### 6.1.1 The Technology Adoption Model (TAM)

The TAM is an information systems theory that investigates and highlights factors affecting users’ acceptance of a technology [56]. Originally, TAM was derived from the psychology-based theory of reasonable action (TRA) and theory of planned behavior (TPB) [56]. The former takes

behavioral intentions as the main predictor of a person’s actual behaviors while the influence of attitude (“the degree of one’s positive or negative feelings about performing the target behavior”) and subjective norms (or the expectations of other people) on the behavior are mediated through the behavioral intention [65]. The TPB is an extension of the TRA by adding the perceived behavioral control to deal with behaviors over which individuals have incomplete volitional control [134]. According to the TPB, attitude, subjective norms, and perceived behavioral control together shape an individual’s behavioral intentions [5].

Following this stream of work, Davis et al. considered that users’ actual use of a system is a behavior [134]. They extended the TRA and the TPB and identified two distinct beliefs to predict a user’s intention to accept and use a technology: (1) *perceived usefulness* is the degree to which the person believes that using the particular system would enhance her/his job performance; and (2) *perceived ease of use*, which refers to the degree to which the person believes that using the particular system would be free of effort [57]. According to this model, a user’s acceptance of any technology, measured by their intention to use this technology, is determined by *perceived ease of use* and *perceived usefulness*. In other words, “a person perceiving technology to be too difficult and not very useful, will most likely try not to use it, whereas a user on the opposite side of the spectrum would very likely do the opposite” [122].

Therefore, we believe that the TAM is an appropriate theoretical model to orient this research because we focus on how the adoption of a new technology (i.e., digital P2P payments) affects people’s offline interpersonal relationships and their future use intention. Using the TAM, in the context of our work, we define

*perceived ease of use*, *perceived usefulness*, and *intend to (future) use* as:

1. **Perceived Ease of Use.** The degree to which an individual believes that using a given payment method (physical money or digital P2P payments) to make interpersonal money transactions would be free of effort.
2. **Perceived Usefulness.** The degree to which an individual believes that using a given payment method (physical money or digital P2P payments) would optimize the peer-to-peer payment experience and improve interpersonal money transactions.
3. **Intend to (Future) Use.** The desire an individual has to continue to use a given payment method (physical money or digital P2P payments) to make interpersonal money transactions

in the future.

## 6.1.2 Factors Associated with Social Impacts of Using a Given Payment Method

In addition to the above-mentioned factors through the lens of accepting and using a new technology, we also consider factors associated with social influences of using digital P2P payments revealed in existing literature [2, 83, 98, 220, 227] and findings from Study 2 when developing our hypotheses. In our study, we examine these factors in both contexts of using digital P2P payments and using physical money and categorize these factors into two specific aspects: immediate social consequences of using a given payment method, and lasting impacts on dimensions of interpersonal relationships through using a given payment method.

### 6.1.2.1 Immediate Social Consequences of Using a Given Payment Method

1. **Perceived Awkwardness.** The degree to which an individual perceives making money transactions with people they know (i.e., having existing interpersonal relationships) via a given payment method as awkward. For example, they may feel awkward when they discuss finances with each other, such as splitting bills, explicitly asking for repayment after some time, or asking for a small amount of money back, especially with people they know.
2. **Perceived Fairness.** The degree to which an individual perceives making money transactions with people they know via a given payment method as fair. For example, they may feel the transaction is fair because it is easier for people to pay their exact fair share (e.g., exactly \$5.60 rather than round down as \$5).
3. **Perceived Peer Pressure (to Use a Certain Payment Method).** The degree to which an individual perceives peer pressure to use a given payment method exists when making money transactions with people they know. For example, to use digital P2P payments, both parties are required to download and use the same digital P2P payment app. This sometimes increases peer pressure on using smartphones, downloading apps, and being open to online payments.
4. **Emotion in Communication.** The degree to which an individual perceives emotion in communication exists when making money transactions with people they know via a given

payment method. For instance, traditional payment methods such as face-to-face cash transactions often provide room for more personal and emotional communication, such as expressing care, gratitude, attention, and even a sense of ritual [154, 204, 234, 241]. In contrast, digital P2P payments, as a computer-mediated payment method, allow people to operate financial exchanges remotely but may eliminate such personal interaction and communication [172].

### **6.1.2.2 Lasting Impacts on Dimensions of Interpersonal Relationships through Using a Given Payment Method**

1. **Perceived Trust.** The degree of trust that an individual perceives they have in a person they know since they adopted a given payment method to make money transactions with the given person.
2. **Perceived Tension.** The degree of tension that an individual perceives they have with a person they know since they adopted a given payment method to make money transactions with the given person.
3. **Emotional Attachment.** The degree of emotional attachment that an individual perceives they have with a person they know since they adopted a given payment method to make money transactions with the given person.

### **6.1.3 Hypotheses Development**

To explore how using digital P2P payment apps for money transactions between known people affects people's offline interpersonal relationships differently compared to physical money, hypotheses were developed grounded in the TAM model and the above-mentioned factors associated with social influences of using digital P2P payments. Specifically, H1 to H4 were developed to measure the immediate social consequences of using digital P2P payments versus physical money between people with existing interpersonal relationships:

**H1:** People will experience less awkwardness from using digital P2P payments than using physical money when making money transactions with people they know.

**H2:** People will experience more fairness from using digital P2P payments than using physical money when making money transactions with people they know.

**H3:** People will feel more peer pressure from using digital P2P payments than from using physical money when making money transactions with people they know.

**H4:** People will experience less emotion in communication from using digital P2P payments than using physical money when making money transactions with people they know.

H5 to H7 were developed to measure and compare the lasting impacts of using digital P2P payments versus physical money on various dimensions of people's existing interpersonal relationships:

**H5:** People will build more trust in those they know, whom they make money transactions with using digital P2P payments than using physical money.

**H6:** People will experience less tension with those they know, whom they make money transactions with using digital P2P payments than using physical money.

**H7:** People will establish less emotional attachment with those they know, whom they make money transactions with using digital P2P payments than using physical money.

Lastly, H8 to H10 were developed to examine how these immediate social consequences and lasting impacts affect people's perception of *ease of use* and *usefulness* of digital P2P payments versus physical money as well as their intention to use digital P2P payments versus physical money in the future:

**H8:** People will perceive better ease of use from using digital P2P payments than using physical money when making money transactions with people they know.

**H9:** People will perceive higher usefulness from using digital P2P payments than using physical money when making money transactions with people they know.

**H10:** People will have a stronger intention to use digital P2P payments than to use physical money when making money transactions with people they know in the future.

#### **6.1.4 Proposed Conceptual Model**

Grounded in these hypotheses regarding the differences between the adoption of digital P2P payments and physical money, we propose a research model to further explore how and why such

differences occur. In this model, we incorporated the adapted TAM to investigate how immediate social consequences of using digital P2P payments can lead to lasting impacts on people’s offline interpersonal relationships and future use intention (see Fig 6.1).

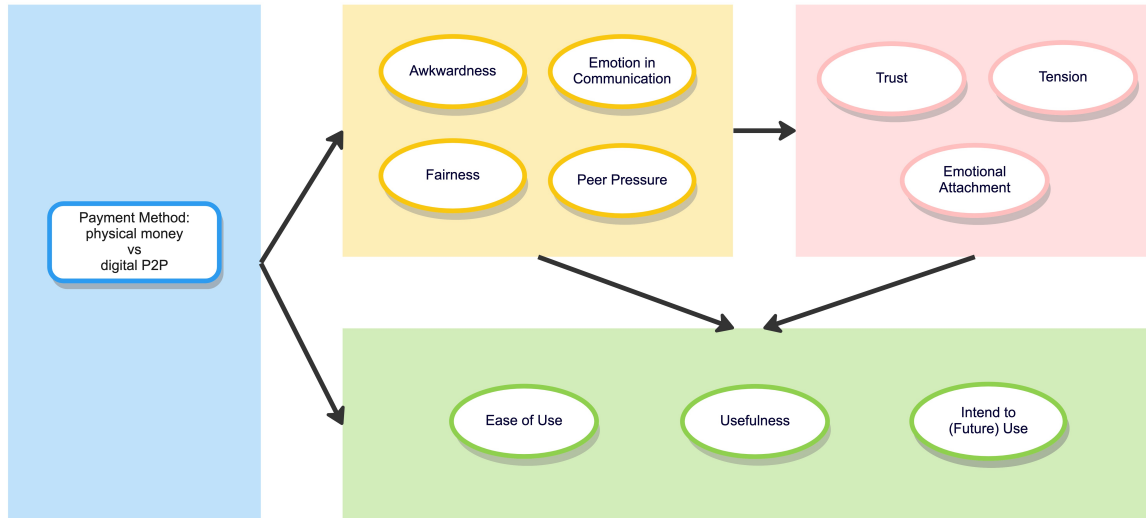


Figure 6.1: Proposed conceptual model for Study 3

## 6.2 Methods

### 6.2.1 Survey Design

To address our research questions and test the proposed hypotheses, we designed an anonymous online survey (see Appendix C), which included 5 sections (see Fig 6.2): demographics; general questions about daily use of digital P2P payments and physical money payments (i.e., through cash); immediate social consequences of using digital P2P payments or physical money; lasting impacts on dimensions of interpersonal relationships through using digital P2P payments or physical money; and recommendations for improving the current designs of digital P2P payments apps. Most scales were repeated twice: once for physical money and once for digital P2P payments.

Specifically, Section 1 presents 7 demographic questions, including age, gender, ethnicity, and residence. Regarding residence, respondents are asked about the country where they grew up, the country they are currently located, community type (e.g., urban, suburban, rural), and how long they have lived there. Answers to these questions indicate how their living environments

Topic	Demographics	Daily Use	Immediate Consequences	Lasting Impacts	Design Recommendations
Type	Multiple choice	7-point Likert scale; open ended; multiple choice	7-point Likert scale (agreement)	7-point Likert scale (agreement)	Open ended question; multiple choice
Examples	<ul style="list-style-type: none"> <li>• Age</li> <li>• Ethnicity</li> <li>• Country of residence</li> <li>• Amount of time living in the community</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• What is the reason you started using P2P payment apps?</li> <li>• With whom do you usually use P2P payment apps to send/receive money?</li> </ul>	<p>"Using digital P2P payments, people and I can make instant transactions easily to avoid having to discuss finances (e.g., splitting a dinner bill, etc)."</p>	<p>"Using digital P2P payments increases the emotional bond between me and the people."</p>	<p>How do you think current digital P2P platforms can be improved to better support your needs for social interactions? Any suggestions?</p>

Figure 6.2: An Overview of the Survey Design

and lifestyles may affect their use patterns of digital P2P payments and how such patterns may potentially affect their offline relationships.

Section 2 focuses on how respondents use digital P2P payments and physical money (i.e., cash) respectively (11 questions respectively). These questions include the frequency of using digital P2P apps or physical money, who they usually use digital P2P payment apps or physical money with; whether they round or pay the exact amount when paying people they know (e.g., friends, colleagues, family members, etc) via digital P2P payments or physical money. Pre-validated scale items of the perceived usefulness, ease of use, and intend to (future) use of digital P2P payments and physical money (i.e., cash) respectively are also included based on the TAM [57].

Section 3 focuses on the immediate social consequences of using digital P2P payments for money transactions between known people versus using physical money, including perceived awkwardness, perceived fairness, emotion in communication, and perceived peer pressure. Section 4 investigates lasting impacts on dimensions of interpersonal relationships by using digital P2P payments for money transactions between known people versus using physical money, including perceived trust, perceived tension, and emotional attachment to people to make money transactions with. Questions in Section 3 and 4 adopt the 7 point Likert scales.

Section 5 presents a combination of multiple choice questions (e.g., the function of splitting a bill, adding a personal memo/note/message in transactions, sending Emojis and Bitmojis in transactions, customizing avatars or profile pictures, etc) and open-ended questions to examine what existing social features of digital P2P payments platforms people value and encourage respondents to offer suggestions and recommendations for improving the future design of digital P2P payments to better support their offline relationships with people they know.



## 6.2.2 Data Collection

The University’s Institutional Review Board (IRB) approved this study for research ethics prior to the recruitment of participants. The survey was developed using Qualtrics, a professional survey platform that complies with the newest industry standards [151]. The survey was distributed through Prolific, a professional online data collection website that has been commonly used by researchers for conducting anonymous online surveys [170]. Prolific offers an international participant pool with at least 130,000 active participants all over the world and a more than 800,000 total pool size. Samples recruited through Prolific can be more demographically representative than lab-based or convenience samples. Several thousand researchers have registered with Prolific to date and Prolific is widely and successfully used in behavioral research and social science experiments to collect reliable and high-quality data [170, 176].

We integrated the Qualtrics survey link into Prolific to recruit respondents and collect responses. Respondents were required to be at least 18 years old at the time of the survey. As a filter question, respondents were asked if they had used any digital P2P payments app before. If they had not, they were not eligible to take the subsequent survey. Another eligibility criterion is if they can write/read English. On average, respondents spent 23.3 minutes completing the survey. Respondents who completed the survey were compensated with \$2. An attention check question was also used to ensure that valid responses were collected and used for data analysis.

A total of 232 participants responded to the survey. After removing respondents who did not use digital P2P apps with people they knew but for other purposes (e.g., only for online shopping) and those who failed the attention check question, a total number of 218 valid responses were used for further analysis.

## 6.2.3 Data Analysis

We followed four steps in the analysis procedures. First, we assessed the reliability and validity of the multiple-item measures that we constructed for this study using confirmatory factors analysis (CFA) [105] in Mplus. CFA helps establish convergent and discriminant validity of the latent variables (e.g., perceived awkwardness, perceived trust, etc) to ensure that the survey items are valid measurements of the constructs [105]. More specifically, convergent validity helps “determine whether the items of a scale measure a single construct (i.e., that the scale is not a combination

of multiple constructs, or simply a collection of items with no common ground), while discriminant validity determines whether two scales indeed measure two separate constructs (i.e., that two scales are not so similar that they actually measure the same construct)” [105]. In CFA, survey items that belong to the same scale are represented by a latent factor. The analysis determines to what extent the item serves as an adequate indicator of the factor (loading).

Therefore, upon inspection of the CFA models of digital P2P payments and physical money dataset (see Appendix D.1 and D.2), we iteratively removed all items of the factor peer pressure [PRES1 (communality: 0.205), PRES2 (communality: negative)] and one item of the factor perceived ease of use [EASE4] (high cross-loadings with several other factors) from both models. To ensure the convergent validity of constructs, we examined the average variance extracted (AVE) of each construct for both CFA models. The AVEs are all higher than the recommended value of 0.50, indicating adequate convergent validity. To ensure discriminant validity, we removed the factor perceived fairness which is highly correlated to the factor perceived awkwardness to ascertain that  $\sqrt{AVE}$  of each construct is higher than the correlations of the construct with other constructs. Both of the final CFA models have a great model fit <sup>1</sup>. As for digital P2P payments model,  $\chi^2(377) = 697.821$ ,  $p < .0001$ ; RMSEA = 0.062, 90% CI: [0.055, 0.070]; CFI = 0.983, TLI = 0.981. Regarding physical money model,  $\chi^2(377) = 709.837$ ,  $p < .0001$ ; RMSEA = 0.064, 90% CI: [0.056, 0.071]; CFI = 0.974, TLI = 0.970.

Second, we tested the developed hypotheses by comparing the estimated standardized value of each factor in Mplus to investigate how these factors differ between the conditions of using digital P2P payments and using physical money.

Third, we examined the research model using structural equation modeling (SEM) to investigate how the hypotheses happen. SEM is one of the most advanced statistical analysis techniques, which combines aspects of factor analysis and regression to enable simultaneous examination of relationships among measured variables and latent variables as well between latent variables [105]. SEM has been widely used for correctional data (e.g., survey data) due to two main advantages: 1) SEM can deal with latent variables (e.g., subjective measures with multiple items, such as perceived awkwardness which has 5 items). In this case, SEM offers additional robustness and precision. 2) SEM allows for testing of multiple mediation effects within a single model. In our case, this allows us

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<sup>1</sup>A model should not have a non-significant  $\chi^2$ . However, this statistic is regarded as too sensitive and an alternative metric here we used [19]:  $\chi^2 / df < 3$  (good fit) or  $< 2$  (great fit). Hu and Bentler [90] propose cutoff values for other fit indices to be: CFI  $> .96$ , TLI  $> .95$ , and RMSEA  $< .05$ , with the upper bound of its 90% CI below 0.10.

to model the influence process of the use of digital P2P payments rather than simply the outcome.

Lastly, we read through all respondents' comments to get a general understanding of how people perceive the functionality of current digital P2P payment services. We then used an inductive, thematic analysis [27, 28] to identify thematic topics emerging in respondents' design suggestions to design future digital P2P payments to promote social connections (e.g., help reducing peer pressure, making transactions smoother, increasing emotion in communication, etc) for further analysis. We carefully examined and reviewed the thematic topics and developed sub-themes (e.g., late into the market; established network already on other payment apps). We also engaged in an iterative process to combine and refine themes and features to generate a rich description synthesizing digital P2P payments users' perceptions and suggestions on revamping the features and functionalities of digital P2P payment services for social connections in the future.

## 6.3 Results

In this section, we first present descriptive statistics regarding our respondents' use patterns of digital P2P payments with people they know. We then present how using digital P2P payment apps and using physical money (i.e., cash) for money transactions between known contacts may lead to different immediate social consequences of such transactions, lasting impacts on their interpersonal relationships, and perceived usability of the given payment method (**focus 1**). We also explain how these differences occur - i.e., how the immediate social consequences of using digital P2P payment apps lead to lasting impacts on people's offline interpersonal relationships and future use intention (**focus 2**). Additionally, we present respondents' design suggestions to design future digital P2P payments to promote social connections.

### 6.3.1 Demographics, Payment Habits, & Digital P2P Payment Apps Usage

#### 6.3.1.1 Demographic Information

Table 6.1 presents the basic demographic information of the 218 valid respondents, which represent a geographically and culturally diverse sample with varied genders, age groups, and ethnicities. Participants come from 35 countries around the world (see Fig 6.3), 51 of them were raised

in Mexico, 48 of them were raised in Portugal, 20 of them were raised in South Africa, 20 of them were raised in Chile, 15 of them were raised in Italy, 14 of them were raised in Poland, 13 of them were raised in Spain, and 3 of them were raised in Australia; India, Ireland, New Zealand, Nigeria, Canada, Hungary, and Greece each had two respondents who grew up in these countries. The 218 respondents currently reside in 23 countries (see Fig 6.4).

<b>Variables</b>	<b>Total (N=218)</b>	<b>Percentage (%)</b>
<b>Gender</b>		
Man	147	67.43
Woman	65	29.82
Non-binary / third gender	4	1.83
Gender fluid	2	0.92
<b>Age</b>		
Young Adult (18-25)	136	62.39
Adult (26-44)	72	33.03
Middle-Age (45-59)	8	3.67
Old Age (60+)	2	0.92
<b>Race</b>		
Asian	9	4.13
Black	24	11.01
Hispanic, Latino or Spanish origin	74	33.94
Middle Eastern or North African	1	0.46
White	99	45.41
Mixed Race: Asian & White	2	0.92
Mixed Race: Hispanic, Latino or Spanish origin & White	9	4.13
<b>Area of Residence</b>		
Urban	138	63.3
Suburban	63	28.9
Rural	17	7.8

Table 6.1: Demographic information of respondents

### 6.3.1.2 Payment Habits

When asked which payment method they prefer to use when making a money transaction with someone they already have an existing relationship (e.g., friends, family members, co-workers, etc.), 133 (61%) chose digital P2P payments; 45 (21%) chose credit/debit cards; 37 (17%) chose physical money (i.e., cash) while the remaining 3 (1%) chose bank transfers.

Regarding why they chose digital P2P payments as their first option to make money transactions with people they already know, 80.3% respondents cited its ease of use (“*It’s easy to use.*”)

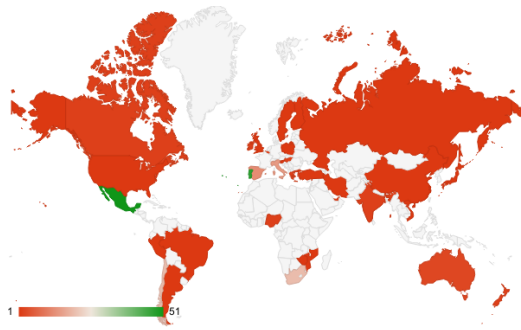


Figure 6.3: Countries where respondents grew up (The color from red to green indicates the number of respondents who grew up in the country: the greener the color, the more respondents grew up in this country; the redder the color, the fewer respondents grew up in this country.)

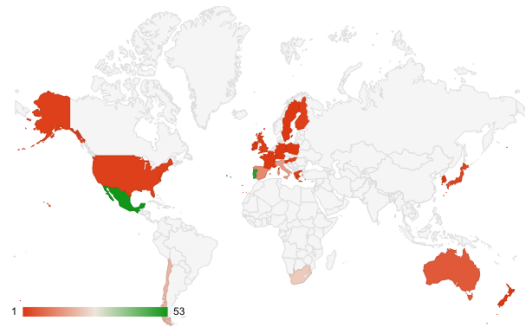


Figure 6.4: Respondents' current residency (The color from red to green indicates the number of respondents who currently live in the country: the greener the color, the more respondents live in this country; the redder the color, the fewer respondents live in this country.)

and 82.1% mentioned its free/low cost (*“It’s free or low cost.”*). Respondents also highlighted its immediacy and timeliness (87.6% for *“It’s instant payment so others can send me money at the moment”* and 58.7% for *“It’s convenient so I do not worry about forgetting to pay the person”*) as great benefits over physical money (only 51.7% and 29.8%, respectively, cited the same reasons mentioned above when these respondents were asked the same questions for physical money).

Respondents also demonstrate varied payment habits based on which payment method they use. Table 6.2 summarizes different rounding strategies people employ when paying or requesting money from people they know using digital P2P payments versus physical money (i.e., cash). Interestingly, respondents who always round (regardless of round up or down) when using physical money to pay people they know are nearly twice as many as those who always round when using digital P2P payments for the same purpose. Likewise, the percentage of respondents who always round when requesting physical money from people they know is almost three times as high as those who always round via digital P2P payments when requesting physical money.

### 6.3.1.3 Digital P2P Payments Usage

Respondents mentioned 38 digital P2P payment services that they have used, including stand-alone software, built-in features of bank software, built-in features of smartphone OS, such as PayPal, Google Pay (Android devices), Cash App (mainly used in USA and the UK), MB WAY (mainly used in Portugal), Alipay (mainly used in China), Samsung Pay (compatible Samsung-

	via Digital P2P Payments	via Physical Money
<b>Paying people who have an existing interpersonal relationship with me</b>		
Always round up (e.g., pay \$5 for \$4.5)	N = 35 (16%)	N = 66 (30%)
Always round down (e.g., pay \$4 for \$4.3)	N = 0	N = 3 (1%)
Pay the exact amount	N = 105 (48%)	N = 74 (34%)
It depends on what kind of relationship I have with the person	N = 56 (26%)	N = 49 (22%)
It depends on the amount (e.g., pay \$4 for \$4.25; pay \$5 for \$4.95)	N = 22 (10%)	N = 26 (12%)
<b>Requesting money from people who has an existing interpersonal relationship with me</b>		
Always round up (e.g., ask people to pay \$5 for \$4.96)	N = 12 (6%)	N = 38 (17%)
Always round down (e.g., ask people to pay \$4 for \$4.5)	N = 6 (3%)	N = 21 (10%)
Ask for the exact amount	N = 125 (57%)	N = 81 (37%)
It depends on what kind of relationship I have with the person	N = 55 (25%)	N = 49 (22%)
It depends on the amount (e.g., ask \$4 for \$4.25; ask \$5 for \$4.95)	N = 20 (9%)	N = 29 (13%)

Table 6.2: Rounding strategies people employ when paying or requesting money from people they know using digital P2P payments versus physical money

produced devices), Venmo (only used in USA), Verse (mainly used in Europe), among others (see Fig 6.5).

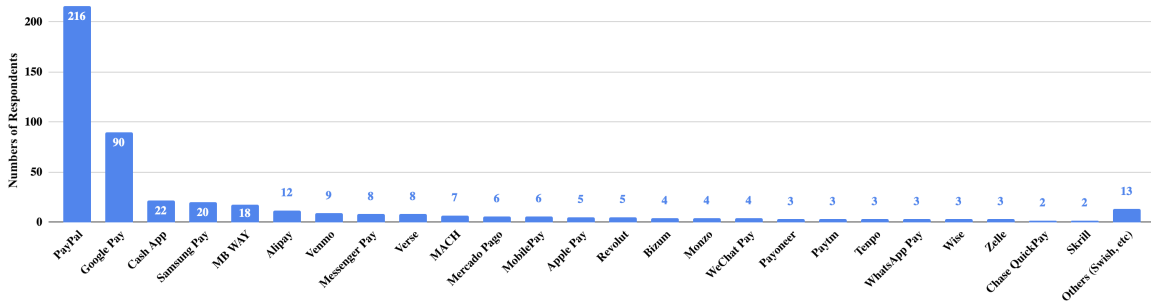


Figure 6.5: Digital P2P payment services respondents have used. (Respondents could select and give multiple answers.)

81% of respondents use digital P2P payments for money transactions with people they know at least once a month (see Fig 6.6), which can be considered as monthly active users (a monthly active user is someone who interacts with an app over a period of 30 days). They have also described several common contexts where they use digital P2P payments for such money transactions with people they know: paying/receiving shared cost (e.g. bar tab, meals, rideshare fare, etc) (60%), lending/borrowing money to/from an individual (55%), paying/receiving reimbursement (e.g., concert tickets, movie tickets) (50%), gifting (45%), and paying/receiving rent/utility fee (44%). Regarding whom they often use digital P2P payments to make such money transactions with, 86% respondents usually use P2P payment apps to send/receive money to/from their friends, which is followed by

family members (67%), acquaintances (47%), significant others (45%), and colleagues/co-workers (40%).

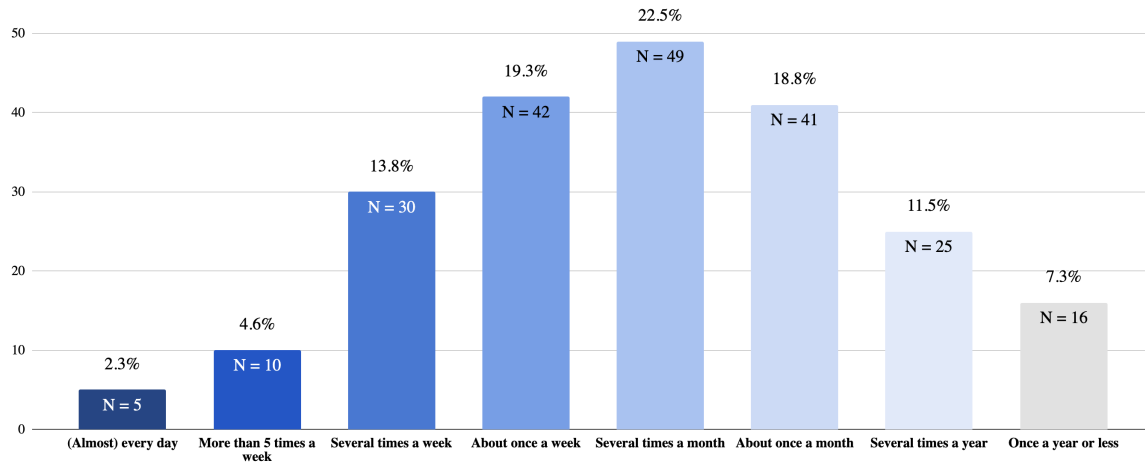


Figure 6.6: Frequency of using digital P2P payments to make interpersonal money transactions with known people

### 6.3.2 Focus 1: Differences in Immediate Social Consequences, Lasting Impacts, and Perceived Usability of Digital P2P Payments vs. Physical Money

To test our hypotheses, we compare how using digital P2P payments versus physical money to make money transactions with known people may differently affect the immediate social consequences of such transactions, lasting impacts on their interpersonal relationships, and perceived usability of the given payment method (see Table 6.3). This thus helps us unpack digital P2P payments' distinct impacts on people's offline interpersonal relationships in comparison to physical money.

Our results show that the differences between digital P2P payments and physical money are statistically significant across all three aspects (immediate social consequences, lasting impacts, and perceived usability) ( $p < 0.05$ ). Worth mentioning is that factors including perceived awkwardness, perceived usefulness, and intend to (future) use show a large effect size. In other words, people feel less awkward via digital P2P payments to a great extent (SD difference: -1.208) than via physical money (i.e., cash) when making money transactions with people they know. Regarding perceived usability, digital P2P payment is perceived as much more useful (SD difference: 1.173) than physical

Table 6.3: Difference between Digital P2P Payments and Physical Money on Each Factor

Factor	SD Difference	P-Value
Immediate Social Consequences		
-Perceived Awkwardness	-1.208	<0.001
-Emotion in Communication	-0.623	<0.001
Lasting Impacts		
-Perceived Trust	0.384	<0.001
-Perceived Tension	-0.558	<0.001
-Emotional Attachment	-0.283	0.005
Perceived Usability		
-Perceived Ease of Use	0.327	0.001
-Perceived Usefulness	1.173	<0.001
-Intend to (Future) Use	1.034	<0.001

**Note:** As higher scores in Perceived Awkwardness mean less awkwardness and higher scores in Perceived Tension mean less tension, we reverse their SD difference values for better readability.

money (i.e., cash); and people have a much stronger desire (SD difference: 1.034) to use digital P2P payments in the future than to use physical money (i.e., cash) to make money transactions with people they know.

Factors such as emotion in communication and perceived tension show a medium or medium to large effect. Our findings show that people experience less emotion in communication (SD difference: -0.623) when making money transactions with people they know via digital P2P payments than via physical money (i.e., cash). However, using digital P2P payments also relieves more tension (SD difference: -0.558) in their interpersonal relationships with people they know than using physical money (i.e., cash). As for perceived ease of use (SD difference: 0.327), perceived trust (SD difference: 0.384), and emotional attachment (SD difference: -0.283), while the results show statistical significance, their effect sizes indicate that the differences between using physical money (i.e., cash) and digital P2P payments on these factors are small. As a result, 8 out of our 10 proposed hypotheses are supported (Table 6.4).

### 6.3.3 Focus 2: How and Why Such Differences Happen

In the previous section, we have provided evidence of significant differences between using digital P2P payments versus physical money in terms of immediate social consequences, lasting impacts, and perceived usability. Grounded in these findings, in this section, we focus on how and why such differences occur. In doing so, we utilize SEM to test our proposed conceptual model by measuring how immediate social consequences of using digital P2P payments can lead to lasting



Hypothesis	Description	Supported or not
H1	People will experience less awkwardness from using digital P2P payments than using physical money when making money transactions with people they know.	Supported
H2	People will experience more fairness from using digital P2P payments than using physical money when making money transactions with people they know.	Not applicable. (The factor did not pass CFA)
H3	People will feel more peer pressure from using digital P2P payments than using physical money when making money transactions with people they know.	Not applicable. (The factor did not pass CFA.)
H4	People will experience less emotion in communication from using digital P2P payments than using physical money when making interpersonal money transactions.	Supported
H5	People will build more trust in those they know, whom they make money transactions with using digital P2P payments than using physical money.	Supported
H6	People will experience less tension with those they know, whom they make money transactions with using digital P2P payments than using physical money.	Supported
H7	People will establish less emotional attachment to those they know, whom they make money transactions with using digital P2P payments than using physical money.	Supported
H8	People will perceive better ease of use from using digital P2P payments than using physical money when making money transactions with people they know.	Supported
H9	People will perceive higher usefulness from using digital P2P payments than using physical money when making money transactions with people they know.	Supported
H10	People will have a stronger intention to use digital P2P payments than to use physical money when making money transactions with people they know in the future.	Supported

Table 6.4: Summary of Supported/Unsupported Hypotheses

impacts on people’s offline interpersonal relationships and future use intention. Having removed the non-significant effects, we analyzed the significant effects. The resulting model has a great model fit:  $\chi^2(414) = 788.494$ ,  $p < 0.001$ ; RMSEA = 0.046, 90% CI: [0.041, 0.050]; CFI = 0.985, TLI = 0.983) (see Fig 6.7). Below, we interpret the causal relationships in this model.

**Payment Method Affects Emotion in Communication.** The use of digital P2P payments leads to less emotion in communication ( $\beta = -0.568$ ) when making money transactions with known people than the use of physical money.

**Payment Method and Emotion in Communication Affect Perceived Awkwardness.** Emotion in communication negatively ( $\beta = -0.318$ ) affects the perceived awkwardness. Using digital P2P payments can directly reduce awkwardness ( $\beta = -1.421$ ) but the reduced emotion in communication caused by using digital P2P payments would increase awkwardness. By calculating the total effect, using digital P2P payments for money transactions between people with existing relationships leads to less awkwardness overall (total effect  $\beta = -1.240$ , see Table 6.5) than using physical money.

**Emotion in Communication and Perceived Awkwardness Affect Perceived Trust.** Emotion in communication positively affects (total effect  $\beta = 0.525$ , see Table 6.5). It was calculated

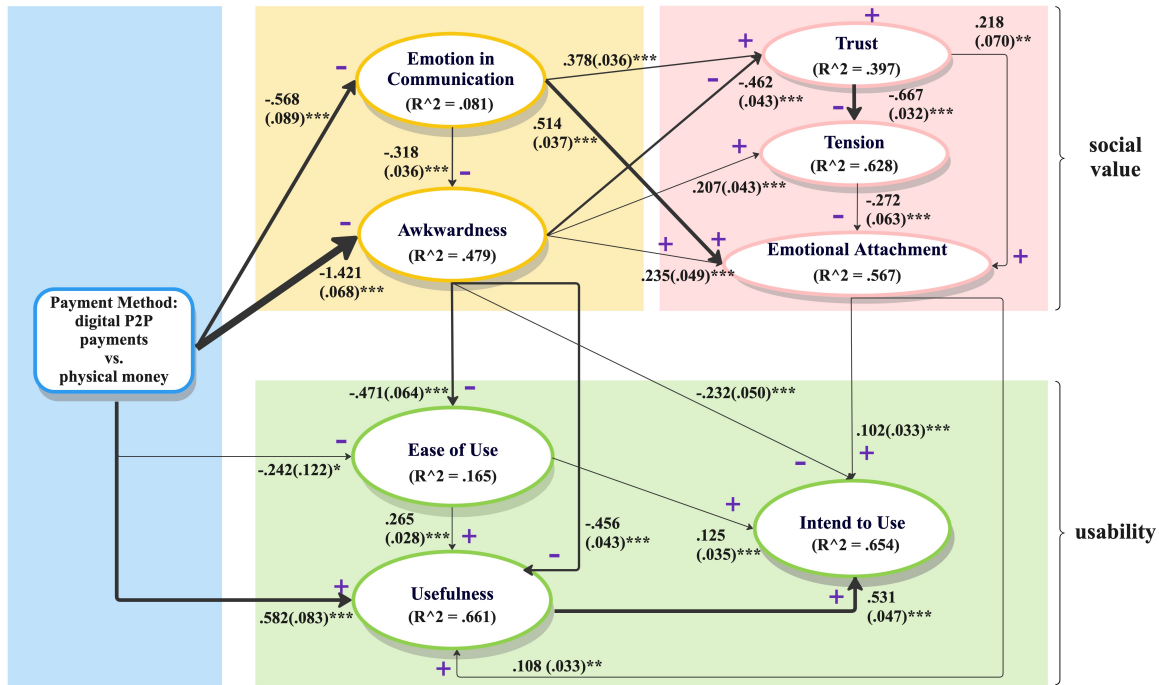


Figure 6.7: The structural equation model for the survey results. Significance levels:  $*** p < .001$ ,  $** p < .01$ ,  $* p < .05$ .  $R^2$  is the proportion of variance explained by the model. Arrows represent causal relationships. Numbers on the arrows (and their thickness) represent the  $\beta$  coefficients (and standard error) of the effect. Factors are scaled to have an SD of 1.

by summing the direct effect (.378) and the effect mediated by perceived awkwardness ( $-.318 \times -.462$ ) the perceived trust whereas the perceived awkwardness negatively affects ( $\beta = -.462$ ) it. Therefore, the reduced emotion in communication of digital P2P payments would lower the perceived trust and the reduced awkwardness of digital P2P payments would increase the perceived trust. By taking these factors together, overall, using digital P2P payments promotes the trust (total effect  $\beta = 0.359$ , see Table 6.5) people have in those they make money transactions with compared to using physical money.

**Perceived Awkwardness and Perceived Trust Affect Perceived Tension.** The perceived awkwardness positively affects (total effect  $\beta = 0.515$ , see Table 6.5) the perceived tension whereas the perceived trust negatively affects ( $\beta = -.667$ ) it. In this sense, on the one hand, the reduced awkwardness of digital P2P payments would help ease the perceived tension; on the other hand, the increased trust of digital P2P payments would reduce the perceived tension as well. Therefore, using digital P2P payments, overall, relieves (total effect  $\beta = -.496$ , see Table 6.5) the tension people experience in their relationships with those they make money transactions with

Table 6.5: Total effect of each factor on other related factors based on the structural equation model

	Payment Method (1: Digital P2P)	Emotion	Awkwardness	Trust	Tension	Emotional Attachment	Ease of Use	Usefulness
Emotion	-.568 (***)							
Awkwardness	-1.240 (***)	-.318 (***)						
Trust	.359 (***)	.525 (***)	-.462 (***)					
Tension	-.496 (***)		.515 (***)	-.667 (***)				
Emotional Attachment	-.370 (***)	.667 (***)	-.006 (0.911)	.399 (***)	-.272 (***)			
Ease of Use	.342 (***)		-.471 (***)					
Usefulness	1.198 (***)		.581 (***)			.108 (**)	.265 (***)	
Intend to Use	.930 (***)		-.601 (***)			.102 (***)	.125 (***)	.531 (***)

Note: Numbers in the table are calculated to represent the  $\beta$  coefficients of the total effect the factor have on the other factor directly affected by it. Significance levels: \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$ .

compared to using physical money.

**Emotion in Communication, Perceived Trust, and Perceived Tension Affect Emotional Attachment.** Emotion in communication positively affects (total effect  $\beta = 0.667$ , see Table 6.5) emotional attachment. In this sense, the reduced emotion in communication by using digital P2P payments would lead to a weaker emotional attachment. Perceived awkwardness has no significant effect on the emotional attachment (total effect  $\beta = -0.006$  ( $0.911 > 0.05$ ), see Table 6.5). In addition, the perceived trust positively affects (total effect  $\beta = 0.399$ , see Table 6.5) the emotional attachment, which means that the increased trust of digital P2P payments would strengthen the emotional attachment. Lastly, the perceived tension negatively affects ( $\beta = -0.272$ ) the emotional attachment, which means that the reduced tension of digital P2P payments would increase emotional attachment as well. By calculating the total effect, using digital P2P payments would slightly weaken (total effect  $\beta = -0.370$ , see Table 6.5) the emotional attachment people have with those whom they make money transactions with compared to using physical money.

**Payment Method and Perceived Awkwardness Affect Perceived Ease of Use.** The perceived awkwardness negatively ( $\beta = -0.471$ ) affects the perceived ease of use. In this sense, the reduced awkwardness of digital P2P payments would increase the perceived ease of use. In addition, using digital P2P payments itself leads to a decreased ease of use ( $\beta = -0.242$ ). Taken together, using digital P2P payments makes it easier (total effect  $\beta = 0.342$ , see Table 6.5) for people to make money transactions with those they know compared to using physical money.

**Payment Method, Perceived Awkwardness, Emotional Attachment, and Perceived Ease of Use Affect Perceived Usefulness.** The perceived awkwardness negatively (total effect  $\beta = -0.581$ , see Table 6.5) affects the perceived usefulness. In this sense, the reduced awkwardness of digital P2P payments would increase the perceived usefulness. In contrast, emo-

tional attachment positively ( $\beta = 0.108$ ) affects the perceived usefulness, which means that a slightly decreased emotional attachment of digital P2P payments would lead to less perceived usefulness. Additionally, the perceived ease of use positively ( $\beta = 0.265$ ) affects the perceived usefulness. As a result, the higher ease of use of digital P2P payments would increase the perceived usefulness. Overall, people perceive that it is much more useful (total effect  $\beta = 1.198$ , see Table 6.5) to make money transactions with people they know via digital P2P payments than via physical money.

**Perceived Awkwardness, Emotional Attachment, and Perceived Ease of Use Affect Intend to Use.** Perceived awkwardness, emotional attachment, and perceived ease of use jointly contribute to people’s future intention to use digital P2P payments. Perceived awkwardness negatively (total effect  $\beta = -0.601$ , see Table 6.5) affects the (future) use intention. We found that the largely reduced awkwardness during money transactions with known people leads to a stronger (future) intention to use digital P2P payments. Emotional attachment positively ( $\beta = 0.102$ ) affects the (future) use intention. We found that the slightly decreased emotional attachment of digital P2P payments leads to weaker (future) intention to use the payment method, digital P2P payments. The perceived ease of use also positively ( $\beta = 0.125$ ) affects the (future) use intention, which means that the higher ease of use of digital P2P payments also increases the (future) intention to use them. By calculating the total effect, we conclude that people are much more eager to continue using digital P2P payments for money transactions with people they know (total effect  $\beta = 0.930$ , see Table 6.5) in the future than to continue using physical money.

### 6.3.4 Recommendations for Designing Future Digital P2P Payments for Promoting Social Connections

Our respondents provided specific design suggestions for improving digital P2P payment services to facilitate diverse dimensions of existing interpersonal relationships. Overall, we identified three emerging themes in their design recommendations.

**Easing Peer Pressure by Creating More Accessibility, Robust Security, and Incentives.** Most people mentioned that they would feel peer pressure from using digital P2P payments because they are either (1) not comfortable with digital P2P payments due to security concerns and unfamiliarity with this new payment methods; or (2) tired of having to download multiple digital P2P payment apps based on different friend groups’ preferences. Therefore, respondents

suggest further highlighting advantages and opportunities of using digital P2P payments to solve these issues by 1) providing more accessibility: for instance, to make apps more compatible with a much wider range of operating systems, to enable transactions without Internet connections, to make the interoperability possible between different digital P2P payment platforms, and to provide easier and more understandable tutorials for on-boarding process; 2) offering higher security: for example, many respondents propose to have features to identify frauds, to allow video message when requesting payment to prevent scams, to make a virtual payment first and then proceed with the real one to avoid incorrect recipients or accounts; and 3) providing stronger incentives: to allow users to earn point rewards for each transaction and to offer discounts, coupons, and raffles if using digital P2P payment apps, among others.

**Further Curbing Awkwardness and Tensions by Providing Faster and More Flexible Transaction Operations.** Respondents believe that current design features of digital P2P payment services may not be capable to support more nuanced and complex transaction scenarios, which may lead to awkwardness and tensions when people use digital P2P payments to deal with money in these scenarios. Therefore, they propose several recommendations: 1) speeding up the process of making transactions: for example, people should be able to select the recipient directly from “recent contacts” or “fast contacts”; or people can schedule recurring payments if they need to make frequent transactions with the same recipient; 2) creating intelligence solutions for shared bills: people can choose specific payment planners or use smart cost sharing suggestion system to get better ways to split bills or to make group payments while still maintaining healthy relationships with people they know; 3) offering an embedded instant messaging system: people should be able to discuss finance-related information and details, keep friendly conversations regarding their transactions, and avoid misunderstandings directly within the digital P2P payment service.

**Improving Ways to Express and Communicate Emotions during Money Transactions.** Respondents also emphasize the need for offering better ways to express and communicate emotions between known contacts when they make money transactions via digital P2P payments. For example, respondents should be able to leverage existing digital P2P payments features to express personal emotion and feelings in a variety of modalities, such as through audio message, video message, emojis, pictures, gifs, among others. In addition, respondents expect to customize their profiles to be more special for close contacts like friends or family members.

## 6.4 Discussion

In Study 3, we have highlighted several significant differences between using digital P2P payments versus traditional payment methods (i.e., physical money) in terms of immediate social consequences of such transactions, lasting impacts on people’s interpersonal relationships, and perceived usability of the given payment method (**Focus 1**). Specifically, people feel less awkward and experience less emotion in communication when using digital P2P payments for money transactions with people they know than using physical money. Compared to using physical money, they also feel more trust, less tension, and less emotional attachment in their offline interpersonal relationships since using digital P2P payments to make money transactions with people they know. Overall, our participants perceive digital P2P payments as more useful and show a stronger desire to use them for money transactions with people they know in the future than using physical money (i.e., cash).

We have also further explained how and why such differences occur by exploring how the immediate social consequences of using digital P2P payment apps lead to lasting impacts on people’s offline interpersonal relationships and future use intention (**Focus 2**). Our findings show that (1) the reduced emotion in communication (*immediate social consequences*) caused by using digital P2P payments leads to more trust and increased emotional attachment (*lasting impacts*); (2) the reduced awkwardness (*immediate social consequences*) caused by using digital P2P payments leads to more trust, less tension, and increased emotional attachment (*lasting impacts*); and (3) the reduced awkwardness (*immediate social consequences*) caused by using digital P2P payments can help raise perceived ease of use, increase perceived usefulness, and strengthen people’s intention to use digital P2P payments in the future (*future use intention*).

In this section, we further unpack potential explanations for our results. Grounded in these insights, we discuss how our work contributes to the existing HCI and HCC literature on computer-mediated financial transactions and interpersonal relationships by highlighting the unique impacts of digital P2P payments on existing interpersonal relationships compared to physical money. We also propose potential design implications for designers and developers to design more supportive and socially satisfactory digital P2P payment platforms in the future by taking the interplay of financial exchanges and interpersonal relationships into consideration.

## 6.4.1 Explaining the Discrepancy between Digital P2P Payments and Physical Money in Social Lives

To further explain our results, in this section, we unpack the discrepancy between digital P2P payments and physical money in our social lives through the lens of immediate social consequences, lasting impacts, and perceived usability.

### 6.4.1.1 Discrepancy between Adopting Digital P2P Payments and Physical Money through the Lens of Immediate Social Consequences

As our results have presented, significant differences emerge in how people feel when making money transactions with known contacts via different payment methods *in the moment*.

First, people feel a substantial reduction in awkwardness when making money transactions with known contacts via digital P2P payments compared to via physical money. Indeed, financial interaction and topics regarding money are always uncomfortable in interpersonal relationships [30, 125, 241]. For example, splitting of the bill in a restaurant is still considered socially and culturally awkward; asking for money back will always be considered an uneasy interaction people have to face with their friends and acquaintances [106, 173]. By using digital P2P payments, on the one hand, parties involved in money transactions between known people can easily and instantly complete a payment *in the moment*, overcoming interpersonal tensions that people often face when using physical money, such as (re)paying time lags and the accuracy of amounts. This thus effectively reduce and avoid the potential awkwardness of having to discuss money and debt among people with established relationships (e.g., friends, families, or colleagues). On the other hand, the electronization of digital P2P payments makes it a less personal and more neutral way to communicate finance-related information, which helps reduce the sense of awkwardness as well. This finding further confirms Park et al.'s work on how people may prefer communication methods with low social richness (e.g., digital P2P apps) when requesting money back from weak social connections such as distant acquaintances [172, 173]. In doing so, using digital P2P payments help people separate them from actual interpersonal interactions when money is involved, which can reduce the impacts of sensitive feelings when talking about money with people they already know [172, 173].

Second, people experience a loss of emotion in communication when making money transactions with others they already know via digital P2P payments compared to via physical money.

Previous studies have suggested that there tends to be less social affection, less communication of intimate feelings, and more detachment when engaging in computer-mediated financial transactions [112, 185, 187]. Likewise, digital P2P payments, as a computer-mediated payment method, effectively shorten the required time for making money transactions and simplify the payment procedures. However, they also lead to more focus on the money transaction itself but less on the rich socio-cultural information that is often embedded in money transactions through physical money (e.g., feelings of attachment, care, gratitude and attention, and sense of ritual) [2, 83, 98, 227, 255]. As Park et al. point out, people may prefer communication methods with high social richness (e.g., in-person interactions) when requesting money back from strong social connections such as close friends [172, 173] so that they do not appear impersonal and business-like. While traditional payment methods such as face-to-face transactions via physical money (e.g., giving cash) often provide room for such personal and emotional communication (e.g., expressing feelings when gifting each other money), as our results have shown, digital P2P payments tend to lack such expressions of emotions.

#### **6.4.1.2 Discrepancy between Adopting Digital P2P Payments and Physical Money through the Lens of Lasting Impacts**

As a result of using different payment methods for money transactions, our results also highlight the distinct, lasting impacts on people’s offline interpersonal relationships based on these immediate social consequences explained in the previous section.

First, since they started to use digital P2P payments, people feel more trust in those they make money transactions with using digital P2P payments compared to using physical money because paying in full and in time often helps build sustainable and reliable interpersonal relationships. For example, Xu et al. highlight how assuring timely repayment impacts the lender’s trust in the borrower and lending decisions [247]. By using digital P2P payments, all transactions are instant and automatically recorded in the system, which leaves little room for misunderstanding. Therefore, as our results show, the immediacy and convenience of digital P2P payments can effectively prevent potential distrust due to intentionally or unintentionally delayed or forgotten payments in people’s social interactions.

Second, people experience less tension in their interpersonal relationships with those they know when they use digital P2P payments to make money transactions compared to using physical



money. This further confirms our prior work on digital P2P payments' positive role in relieving tensions in close interpersonal relationships [118]. In particular, using digital P2P payments, on the one hand, effectively loosens the tensions between the financial stress (e.g., need repayment as soon as possible) and the social pressure on maintaining a friendship (e.g., not to annoy friends when asking for money back). On the other hand, using P2P payments may also help avoid unnecessary conflicts that physical money could introduce to interpersonal relationships. For example, rounding the payment down all the time when paying in cash (e.g., paying a \$5 bill rather than the exact amount of \$5.46) often makes people feel being taken advantage of. In contrast, it is easy to ensure that everyone pays the exact amount when using digital P2P payments (e.g., entering the number \$5.46), leading to smoother and more accurate money transactions and thus relieving potential interpersonal conflicts.

Third, people establish a less emotional attachment to those they know when they use digital P2P payments to make money transactions compared to using physical money. Emotional attachment can be broadly defined as an emotional bond or link between individuals, which reflects the sense of liking, connection, and closeness a person feels to others [24, 29, 175, 202]. Money transactions via physical money (e.g., exchanging cash) often involve face-to-face interactions and potentially more interpersonal communication in such interactions. In contrast, the communication and expression of emotions can be largely lost during technology-mediated money transactions without face-to-face interactions (e.g., digital P2P payments), which may harm people's interpersonal relationships in the long run. Indeed, our results show that people's emotional attachment to others involved is reduced, which aligns with previous research's arguments on diffused or missing social affection in computer-mediated relationships [187]. However, building emotional attachment is often a cumulative and longitudinal process that can be affected by many other factors. In fact, some researchers have stated that the differences between computer-mediated communication and face-to-face communication are not highly significant and can even dissolve over time [231, 232, 233]. This may also help explain the small effect size (SD difference: -0.283) of the difference between the impacts of using physical money versus using digital P2P payments on emotional attachment in our study.

### **6.4.1.3 Discrepancy between Adopting Digital P2P Payments and Physical Money through the Lens of Usability**

Our results have also highlighted digital P2P payments' usability advantages over physical money for money transactions between people with established relationships. Obviously, adopting digital P2P payments indeed creates additional challenges for conducting interpersonal money transactions, which involve having a digital device (e.g., smartphone, smartwatch, and tablet), downloading the software, and having the necessary ability and information literacy to operate online payments and deal with potential technical issues. For example, an AARP Research report has pointed out that many people could not recognize and handle fraud/scam risks when using digital P2P payments [46]. These challenges thus make money transactions through using physical money a generally easier process than using digital P2P payments, which is confirmed by our results that digital P2P payments themselves negatively affect the perceived ease of use ( $\beta = -0.242$ ). However, our results also reveal that the largely reduced awkwardness involved in money transactions between known people through using digital P2P payments, along with the easy-to-understand interface and simple payment process, significantly mitigate the above-mentioned usability challenges. Therefore, in our study, people, in fact, perceive digital P2P payments as better ease of use and more useful than using physical money when making money transactions with people they know, due to their simplicity, convenience, and benefits for interpersonal relationships. Compared to physical money, our participants also have a stronger intention to continue using digital P2P payments for making money transactions with people they know. In this sense, our results further confirm recent technology reports on the rising demand and popularity of digital P2P payments across various age groups [58, 182, 253]. For example, a recent survey conducted by LendingTree in May 2022 showed that 84% of consumers have used digital P2P payment services [58].

### **6.4.2 Design for Supporting Interpersonal Relationships through Digital P2P Payments**

Grounded in our results and our reflections, we propose two high-level directions for rethinking digital P2P payments design to mitigate their trade-offs between reducing interpersonal conflicts and distancing interpersonal closeness.

#### **Shifting Unnecessary and Unwanted Social Interactions Regarding Money from**

**People to Technology Applications.** Our study points out digital P2P payment services' significant advantage to reduce or avoid awkwardness in money transactions between known contacts, thus promoting trust and relieving tension. Essentially, it is the digital P2P payment applications themselves that take on the negative social capital when money is involved - the social pressures placed on individuals when dealing with money [164, 241]. Our respondents' design suggestions also echo the statement and highlight to maximize the nature of digital P2P payment apps to serve user's financial and social needs for facilitating interpersonal relationships.

In this sense, we summarize that a potential way to design digital P2P payment platforms to better support interpersonal relationships would focus on transferring the friction that may arise between people over money transactions to the platform itself, thus eliminating complaints and grievances that may harm existing interpersonal relationships when money is involved. For example, the digital P2P payment platform can be designed to automatically send system-generated text messages, rather than messages affiliated with people's personal phone numbers, to request repayment or cost-sharing. This feature may help tone down the sense of awkwardness and the personal nature associated with money transactions where people need to request money from others (e.g., "It is the system, not my friend, that sends me a reminder to pay them back."). In addition, as Venmo's social awareness streams offer general visibility of others' transaction activities to create a sense of someone's payment habits, digital P2P payment platforms can also automatically generate a public or group-wide credit rating of users based on specific criteria such as the timeliness of people's repayments and whether people round up/down or pay the exact amount. This feature may naturally promote the habit of paying in time and in exact amounts among known contacts, which can reduce the potential interpersonal tensions if someone has to be constantly reminded to pay in time and in the exact amount. In summary, digital P2P payment services should be designed in a way to replace certain social interactions that people are reluctant to perform when dealing with money with known contacts (e.g., reminding friends of money they owe) to shift conflicts, thus helping maintain and smooth existing interpersonal relationships even when money is involved.

**Raising Emotional Awareness in Computer-Mediated Money Transactions by Reinforcing Cultural Sensitivity.** Computer-mediated communication has often been considered a cold and impersonal medium where emotions are very difficult to express [52, 185, 212]. To cope with this challenge, several digital P2P service providers have made efforts to facilitate expressions of emotions when conducting money transactions. For instance, PayPal introduced holiday digital

greeting cards [181]; Venmo added social awareness streams, emojis, and gift-wrapping payment features [36].

In addition to these traditional social features that mainly try to provide various modalities to communicate, we argue that integrating digital P2P payments with local cultural expectations would be a promising approach to raise emotional awareness in such computer-mediated transactions. One such example is WeChat Pay’s digital “red envelopes,” which is a specific concept for monetary gifting at ceremonial occasions including childbirth, Chinese New Year, marriage, birthday, promotion among others in the Chinese culture. In this sense, making money transactions through the digital “red envelopes” acts as a new way to celebrate known contacts’ success or important life events with deep cultural meanings, which helps maintain interpersonal relationships and traditional ties over distance [106].

As our results have shown, using digital P2P payments is a popular, worldwide trend. This means that various regions and countries often tend to use different digital P2P payment services that are catered to their cultures. Understanding how different cultural expectations and interpretations of how and when digital P2P payments should be used may help HCI researchers and designers build more culturally sensitive digital P2P payment apps that better serve specific cultures’ and user groups’ social needs and payment habits. In this sense, raising emotional awareness in digital P2P payment platforms by reinforcing cultural sensitivity would be a promising direction for future design and marketing strategies.

## Chapter 7

# Study 4: Research through Design: (Re)Designing Digital P2P Payment Services to Facilitate Social Connections

Grounded in empirical findings from Study 1, 2, and 3, Study 4 adopts the research through design (RtD) approach [258, 259] with a specific emphasis on participatory design (PD) activities [196, 211] to further advance our knowledge and understanding of how digital P2P payments systems can be redesigned to better support people's social connections with individuals they know. The main goal of Study 4 is to both elicit and qualitatively investigate user needs and user-generated design solutions for digital P2P payment services that can better support people's social connections. In doing so, two rounds of PD activities were conducted to explore, understand, create, and reflect upon potential design concepts and directions for designing future digital P2P payments to support social connections.

## 7.1 Why Research through Design and Participatory Design

Throughout Study 1, 2, and 3, while many participants acknowledged the various benefits of using digital P2P payments for personal money transactions, they tended to consider it a double-edged sword for both financial activities and social interactions. With the burgeoning presence of digital P2P payments in people’s daily life, it is important to understand and identify effective strategies and design directions for strengthening the advantageous aspects and mitigating negative impacts digital P2P payments on modern day computer-mediated social connections may exert.

To achieve this goal, Study 4 adopts the RtD approach [258, 259] with a specific emphasis on participatory design activities [196, 211]. We chose the RtD approach because it is a well-established design research approach in HCI that integrates empirical research and design processes. This approach takes advantages of unique insights gained through design practice to enable designers to gain a deeper understanding of complex and future-oriented issues in the design field and develop more effective and meaningful design solutions [76, 259]. In this sense, RtD can result in several forms of theory, such as conceptual frameworks and guiding philosophies [257, 260].

In particular, PD is a key component of the RtD approach. As a widely used HCI method, PD activities engage users in the design process directly and proactively through a collaborative approach [196]. Traditional user-centered design processes focus on looking for ways that ensure it meets the needs of users by professionals. PD, instead, creates the space for professionals and all other stakeholders to work together on a shared vision [193]. Such co-creation boosts the effectiveness in engaging co-designers as an active part of the design process (e.g., knowledge development and idea brainstorming) which is vital to the co-creation process [158].

Previous research has shown that research through design approach, with a focus on participatory design workshops, can lead to innovative and effective design solutions that are well-received by diverse target users [11, 40, 66, 223]. In this dissertation research, the use of PD will uniquely benefit the goals of this work as it involves potential users in the design process of a system to reconfigure the relationships between technology designers and users and align technology with how people desire to conduct their activities [39, 100]. Digital P2P payments users themselves should play a pivotal role in envisioning how digital P2P payments services should be (re)designed to better support their social connections in the future, specifically as a part of the design process. In doing so, we can ensure that actual users’ voices and opinions can be heard, and the designed technologies

will indeed be supportive for these users' social needs.

Therefore, by leveraging the RtD approach with a specific emphasis on PD activities, Study 4 aims to (1) directly involve actual digital P2P payments users in the design process and making design decisions; (2) gain a deep understanding of not only users' needs but also the underlying motivations, values, and beliefs that inform their design process and design decisions; and (3) further advance our knowledge of how digital P2P payments systems can be redesigned to better support people's social connections with individuals they know.

## 7.2 Methods

### 7.2.1 Co-designers

**Co-designers Recruitment.** Participants in PD activities can be considered “co-designers” (i.e., people who are not trained in design working together with designers in the design and development process) [194]. In Study 4, they were expected to be the target users of digital P2P payments who have rich experiences in using digital P2P payment services so that they were able to relate to usage scenarios and actively engage in the design process and design decision making. To recruit co-designers for Study 4, at the end of the survey in Study 3, we included a question to ask respondents if they would be interested in participating in the following PD study to help improve the design of current digital P2P payments services for social connections. If they were interested, they would provide their contact information such as an email address. A snowball sampling was also used to seek for eligible participants for the PD study. As a result, 5 participants agreed to participate in the PD study. We coordinated with each participant to identify appropriate dates and time to attend two rounds of PD activities in Study 4.

**Co-designers Demographics.** Out of the 5 co-designers, 3 self-reported as women and 2 as men. They aged from 24 to 30 years old with an average age of 26.5 years old. 3 self-reported as Asian (2 as Chinese, 1 as Indian) and 2 as White. Table 7.1 summarizes demographic information of co-designers, along with information about digital P2P payment services they have used, how long they have used the services, and places where they grew up and live now.

## 7.2.2 Participatory Design Activities

### 7.2.2.1 Round 1 PD Activities

We conducted the first round of PD activities in the form of a focus group. This round of PD activities was held in a hybrid way: 4 of the 5 co-designers attended in-person and 1 joined the focus group via Zoom. Round 1 PD activities were structured in the following steps and lasted 2 hour and 8 minutes in total.

**Warm up.** Round 1 PD activities started with an overview and introduction to the PD study, including background and our objectives. Co-designers then were informed of the consent document, ground rules, their role in the study, and other relevant information. Upon obtaining verbal consent from the co-designers, we began the audio recording of the PD activities and explained the agenda. Co-designers were asked to briefly introduce themselves to each other.

**Group Discussion.** After the warm-up activities, we asked each co-designer to recall their basic usage of digital P2P payments compared to physical money (i.e., cash). After all co-designers shared their usage experiences, we presented our previous findings in this dissertation research about advantages, disadvantages, immediate social consequences, and lasting impacts of using digital P2P payments on offline interpersonal relationships between people who already know each other. Co-designers were asked to reflect upon if any part of the findings resonated with their own experience and in which ways. We encouraged the group to discuss each other’s experience and speak out their own opinions and reflection. During the group discussion, we also asked follow-up questions to probe more thoughts and reflections from co-designers as well as to ensure their discussion staying on the right track. After the group exhausted their responses, we summarized the takeaways according to their discussion and moved to the next step: collectively generating design ideas to improve digital P2P payments services to reinforce benefits (e.g., reduced awkwardness, ensured fairness, more trust,

Table 7.1: Demographic information of co-designers

ID	Gender	Age	Self-Reported Ethnicity	Digital P2P Payment Options	Experiences (Years)	Place where Grew Up	Area of Residency
C1	Woman	27	White	Venmo, Apple Pay	7	Suburban	Between suburban and rural
C2	Man	25	White	Venmo	6	Suburban	Between suburban and rural
C3	Woman	N/A	Chinese	WeChat Pay, Alipay, Zelle, Venmo, PayPal	10	Urban	Suburban
C4	Woman	30	Chinese	WeChat Pay, Alipay, Zelle, Venmo, Cash App	10	Urban	Suburban
C5	Man	24	Indian	Venmo	12	Rural	Suburban

**Note:** N/A – participants preferred not to answer.



and less tension) and address potential issues (e.g., lost emotions in communication, increased peer pressure, and decreased emotional attachment) for existing interpersonal relationships that have been highlighted in our previous findings.

**Brainstorming and Ideation.** Our previous findings in Study 1, 2, and 3 lead to a core question: How can future digital P2P payments systems be designed to better support people’s social connections with individuals they know? Specifically, our findings have highlighted using digital P2P payments would be a double-sword for people’s existing interpersonal relationships with known contacts: it helps reduce perceived awkwardness, ensure sense of fairness in the moment, and promote trust and relieve tensions in the long term; it also results in the lack of emotions in communication and higher peer pressure.

To address this question, it is important to explore how actual users of digital P2P payments systems envision what features or functions future digital P2P payment apps should have to 1) further strengthen the positive social consequences and lasting impacts (e.g., reduce more awkwardness, relieving more tension, etc); and 2) to mitigate negative social consequences and lasting impacts (e.g., increasing emotion in communication, etc) of using digital P2P payments.

In order to facilitate the process of brainstorming, we adopted Crazy 8’s, a widely acknowledged and used design sprint method for rapid idea generation [75], to encourage participants to come up with creative ideas of how we can re(design) future digital P2P payments services to strengthen digital P2P payments’ positive consequences for social connections in terms of immediate consequences and lasting impacts while also mitigating negative consequences. Co-designers would sketch ideas individually, diverging from the group, and then converging back as a group, voting, and building the best idea from individual ones [13]. All participants followed the steps detailed below (Figure 7.1):

1. Each co-designer was given an A4 sheet of paper and asked to fold it into 8 equal sections.
2. We set a timer for 8 minutes.
3. Within the 8 minutes on the clock, all co-designers were asked to silently sketch out 8 different solutions for strengthening digital P2P payments’ positive consequences for social connections in terms of immediate consequences and lasting impacts while also mitigating negative consequences.
4. When the timer pinged, co-designs stopped sketching and took turns to share their ideas with the whole group.
5. After all co-designers presented their design suggestions, they were given color-coded

stickers to vote on their 3 favourite design ideas out of all solutions that the whole group generated.

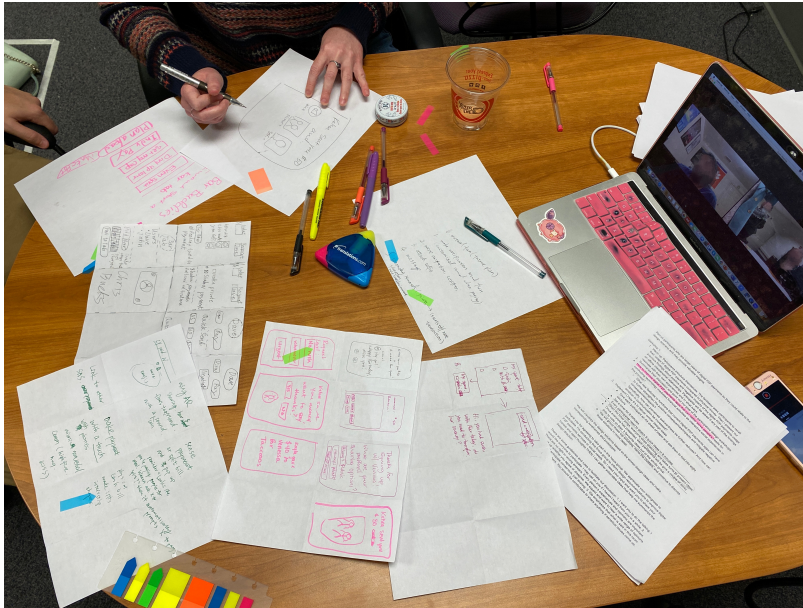


Figure 7.1: Co-designers sketched their design ideas and voted their favourite design suggestions.

### 7.2.2.2 Creating Initial Prototypes

During Round 1 PD activities, co-designers generated 27 design ideas for strengthening digital P2P payments' positive consequences for social connections in terms of immediate consequences and lasting impacts while also mitigating negative consequences. After co-designers voted for the most compelling and valuable ideas as their favorites following the Crazy 8 exercise's principle, we made it a priority to develop wireframes and high-fidelity prototypes for the selected favorite ideas, as these votes demonstrated actual users' (co-designers') collaborative decision-making on how to better understand and design future digital P2P payments to support their social connections in their own views. Overall, 1 idea got 5 votes; 1 idea got 3 votes; 2 ideas got 2 votes; and 3 ideas got 1 vote.

After we identified these potential design ideas collectively highlighted and voted by our co-designers, we developed the low-fidelity wireframes and high-fidelity interactive prototypes using the Figma prototyping software (a collaborative interface design tool) [213]. The wireframe designs roughly outlined blueprints based on selected favorite design ideas [124] and only covered elements (e.g., layout and components of the main interface) of the interface of a digital P2P payments

platform. The goal of creating wireframe designs was to craft high-fidelity prototype designs more easily and smoothly in the next step. Based on the basic wireframes, we then created interactive prototypes with full-color, real images and graphics, and descriptive content to be as close as possible to an actual representation of the user interface [230]. These initial high-fidelity prototypes were then used in the Round 2 PD activities for further review, reflection, discussion, and refinement.

### **7.2.2.3 Round 2 PD Activities**

We conducted the second round of PD activities with the same 5 participants in the form of a focus group as well. This round of PD activities was held online via Zoom and video and audio recorded, which lasted 47 minutes. It began with a brief review and reflection of Round 1 PD activities. We then demonstrated the initial interactive prototypes we created for co-designers to collaboratively review and reflect on to what degree these redesigns could 1) further strengthen the positive consequences and impacts (e.g., reduce more awkwardness, relieving more tension, etc) in our previous findings and in their own Round 1 PD activities; and 2) to mitigate negative consequences and impacts (e.g., increasing emotion in communication, etc) of using digital P2P payments in our previous findings and in their own Round 1 PD activities.

Co-designers were asked to give specific feedback regarding the initial prototypes and discuss if these redesigns aligned with their understandings of how to further strengthen the positive consequences and impacts and mitigate negative consequences and impacts of using digital P2P payments for their social connections. They were asked to offer potential changes, redesigns, and additions with the initial prototypes. We then iterated on the initial prototypes by synthesizing co-designers' feedback and further understanding their needs for using digital P2P payments for social connections. In doing so, we gain new knowledge of how digital P2P payments systems can be redesigned to better support people's social connections with individuals they know from actual users' own perspectives and participation.

### **7.2.3 Data Analysis**

After Round 1 and 2 PD activities were complete, video recordings were first transcribed for further data analysis. We conducted an inductive thematic analysis [27, 28] of the collected data because qualitative methodologies are well-suited for investigating participants' (i.e., co-designers') rich life experiences and social needs as well as embedded rationales behind their design ideas.

Similar to Study 2, we did not seek inter-rater reliability in our analysis but endeavored to identify recurring themes of interest, detect relationships among them, and organize them into clusters of more complex and broader themes.

In doing so, our analytical procedures were: (1) Familiarizing ourselves with the data: we closely read through the co-designers' narratives line by line to identify pieces of information that were relevant to our core question by highlighting them and taking notes and to obtain a holistic sense of their expectations and solutions for digital P2P payments to benefit social connections; (2) Generating initial codes: we began an iterative coding process. We carefully assigned preliminary codes to identified pieces of information, eliminated redundant codes, and identified if the same highlighted information was supporting multiple codes. For example, the quote *"I think having the option to send more nuanced thank-yous to people, especially in gift giving. So maybe like 'A sent you money for your birthday. Would you like to say thanks?' and say yes. And it can either be text box or voice option or like video or something like that to increase the relationship building."* was coded as "prompting users to send notes back," "sending thank-you notes in a more nuanced way," "having more options to create memos/notes such as text, voice, or video," and then combined into "Prompt users for further communication and enrich ways that notes/memos express user's nuanced emotion, such as video, audio, text, etc"; (3) Searching for themes: we categorized codes into thematic topics related to our core question based on Study 2 and Study 3 of influences digital P2P payments exerted on people's existing relationships and developed sub-themes emerging in co-designers' design suggestions. For example, codes pertaining to secondary rewards from each transaction via were categorized as reducing awkwardness. Some subthemes were developed in this particular theme, such as "increase the enjoyment of making digital P2P transactions"; (4) Reviewing themes: we continued to integrate and refine themes and subthemes to streamline co-designers' random design ideas as design solutions to best capture and represent the data in relation to the core question; (5) Defining and naming themes: we named the final set of themes and subthemes. At this stage, we considered subthemes across the entire data set as underlying user needs; and (6) Producing the report: we drafted the structure of the findings by mapping design solutions with our understanding of underlying user needs for each influence. The goal of this phase was to create a narrative structure where all findings flowed naturally and coherently.

## 7.3 Results

Our findings in previous studies have highlighted both positive social consequences and impacts (e.g., reducing more awkwardness, relieving more tension, etc) and negative social consequences and impacts (e.g., increasing emotion in communication, etc) of using digital P2P payments within people already know each other. These findings thus inform the focus of our two rounds of PD activities on strengthening such positive consequences and impacts and mitigating negative consequences and impacts. Using the research through design approach, we were able to gain a deeper understanding of complex and future-oriented issues in this specific design field and develop more effective and meaningful design solutions [76, 259]. Specifically, through the PD activities, we were able to summarize 29 design solutions with co-designers at the end and identify 11 underlying user needs that lead to these design suggestions. In this section, we report how these user-generated design solutions revolve around four main focuses: reducing awkwardness, enhancing fairness, decreasing peer pressure, and increasing emotion, which help us gain new knowledge of how digital P2P payments systems can be redesigned to better support people’s social connections.

### 7.3.1 Focus 1: Understanding and Designing for Reducing Awkwardness

Through these PD activities, we identified five design themes regarding reducing perceived awkwardness while making personal money transaction with known contacts via digital P2P payments to help facilitate existing offline interpersonal relationships.

**1. There should not be any dispute or ambiguity about shared activities and shared bills:** Co-designers believed that if digital P2P payments sender and recipient do not have shared awareness of events or activities they participated in together, this might lead to awkwardness in the money transaction process due to potential arguments and disagreements. They, thus, proposed to have a record of events that users experienced together within the digital P2P app. Users should be able to easily add people who also participated in the same event, and thus the record will be shared with those who are involved in the event (see Fig 7.2). This feature will allow all parties involved to track the shared bills together, which can create a shared awareness of their money transactions and joint activities related to such transactions. In Round 2 PD activities, co-designers further highlighted that people should be able to search, review, and check the archived records easily. In doing this, using digital P2P payments could avoid potential dispute and argument

that might undermine existing interpersonal relationships.

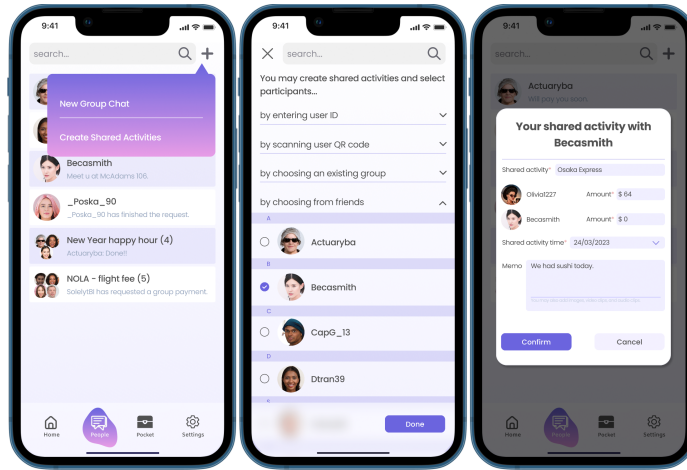


Figure 7.2: People can easily create shared activities with known contacts.

**2. There should be no need to remind others of shared bills in a personal way:**

Several co-designers highlighted the importance of leveraging digital P2P platforms to make people feel “less personal” when they need to chase or remind others of owing money. For example, co-designers set up different urgency levels of reminders, which would be sent by the P2P platform/app as official platform-generated messages rather than from someone’s personal phone number. In this way, people can customize how they would remind others who have varied repayment habits of paying them back (see Fig 7.3). Yet, they still can make such reminders look less “personal” so the other party would not feel embarrassed or offended. Even for the shared record idea mentioned above, co-designers believed that future digital P2P payment platforms should notify people involved that this particular event/activity record was created and documented within the app, which could also be seen as an implicit reminder for those who need to repay others. Similar to our previous findings, our co-designers also felt that chasing and/or reminding people they know (e.g., friends) of repayment can be embarrassing and awkward. Therefore, having a feature to “officially” rather than “personally” remind people that they still owe money would be essential for using digital P2P payments between known contacts.

**3. Making personal money transactions should be more fun:** Similar to our previous findings, our co-designers also felt that money is an inherently awkward subject between people who know each other, as finance-related activities could be sensitive and judgmental. Co-designers thus suggested making personal money transactions more fun to mitigate such sensitivity and awk-

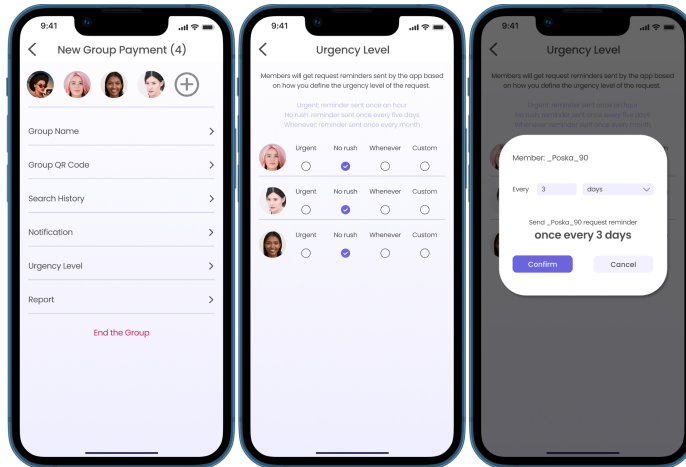


Figure 7.3: People can customize different urgency levels of reminders for specific group payment members.

wardness when money is involved between known contacts. For example, digital P2P payments users could customize their virtual banknotes as different shapes (see Fig 7.4), or associate transactions with customized ring tones. In Round 2 PD activities, co-designers felt the design was visually appealing and offered positive feedback that these “fun” features would help make the personal money transaction process more delighted and less serious, which may reduce the feeling of awkwardness.

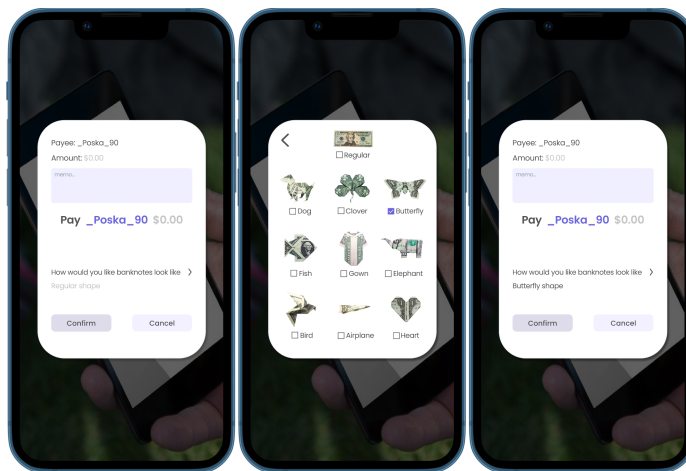


Figure 7.4: People can customize which shape they expect their virtual banknotes to look like.

**4. Digital P2P payments should be designed to encourage people to complete money transactions fast and in time:** Personal money transactions via digital P2P payments can take place both synchronously and asynchronously. This indicates that some people may not pay



Figure 7.5: People can check their friends’ trust scores and the trust score rank.

immediately but delay the payment or ignore reminders of payment requests. Therefore, completing personal money transactions in time is vital to reduce or even avoid perceived awkwardness between known contacts. Therefore, co-designers highlighted that digital P2P payments should be designed to encourage people to do so. For example, they borrowed ideas from rewarded advertising to contend that digital P2P payment platforms should offer better rewards if users responded to money-requests and complete transactions in a timely manner. Through such design, people are encouraged to be reliable and responsible to finish request transactions as soon as possible. In addition, co-designers expected that digital P2P payment platforms should help make people aware of how trustworthy and responsible others are. For example, similar to FICO score that tells lenders how likely a consumer is to repay borrowed money based on their credit history, people will also obtain trust scores based on their average response rate to money-requests. Based on the idea, in Round 2 PD activities, co-designers thus suggested an app-wide trust rank according to these trust scores, which can show who always completes money transactions in a timely manner (see Fig 7.5). In this sense, there is great chance that people do not need to worry about potential arguments, shame, and awkwardness if making personal money transactions with this particular user. In addition, this may also motivate people to be reliable and responsible for paying others back in time, because such ranking may affect their social reputation in regard to finance-related activities within their social networks.

**5. Digital P2P payments should provide more nuanced ways to split bills:** Study 2 showed that having to discuss finances, such as splitting bills and explicitly requesting money transactions especially with known contacts could lead to a potential embarrassment. Co-designers’



agreed with this highlight and suggested that digital P2P payments should provide more nuanced ways to help people split bills to avoid the potential embarrassment and discomfort associated with discussing “how to split.” For example, they proposed a potential solution of “requesting group payment” that includes various ways of splitting shared bills by a simple one-click according to specific situations and contexts, such as splitting bills evenly, splitting bills as group member defines, and so forth (see Figure 7.6). In Round 2 PD activities, co-designers felt the initial prototype was useful and effective to achieve this goal but highlighted that when users need to request group payment from others, such a feature of various ways of splitting shared bills should be presented as a more straightforward and noticeable way (e.g., at the top of the main interface. Meanwhile, co-designers discussed that adding a group chat room for instant real-time messaging should be considered if the group would like to discuss more details about the group payment with each other.

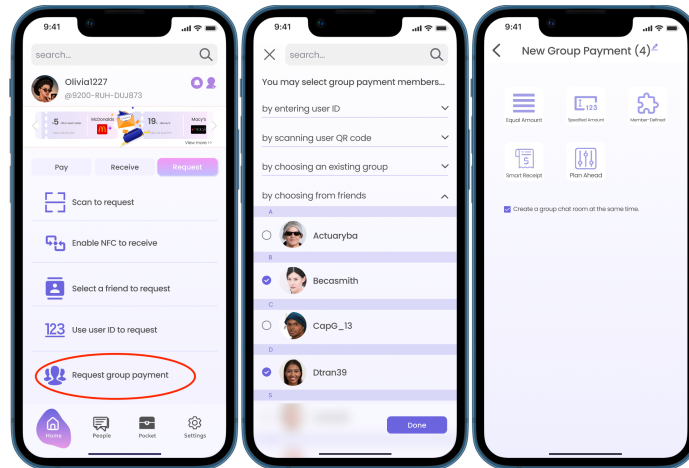


Figure 7.6: People can easily request a group payment and add group members.

### 7.3.2 Focus 2: Understanding and Designing for Ensuring Fairness

We also identified two design themes regarding ensuring and enhancing fairness while making personal money transaction with known contacts via digital P2P payments to help facilitate existing offline interpersonal relationships. In particular, these design themes center on a core user need for relieving the pressure of letting a single user make a payment for the whole group and asking everyone for reimbursement.

In doing so, co-designers specifically proposed to 1) allow users to easily pay only what they actually spend on; 2) avoid group payment payers to advance the payment with their own money.

Regarding 1), for example, co-designers designed a new digital P2P payments feature called “Smart Receipt.” This feature will allow users to scan their receipt, automatically detect the content of the said receipt, and let users select only the item(s) that they are responsible for (see Fig 7.7).

Regarding 2), co-designers put forward the solution to allow a group of people to deposit money based on the estimated amount of the planned event in a group payment account (see Fig 7.8). In doing so, a certain user can just use the deposit to pay the shared bill instead of paying out of pocket using their own money and chasing people for reimbursement later. This particular payer will be able to re-edit the group payment afterwards according to the actual amount of spending. Members will be refunded for any over-payment or will be notified by the platform to make a supplemental payment for any deficiency. In summary, co-designers believed that instead of assuming all payment responsibilities in advance, this new design would ensure every responsible payer shoulder their fair rather than posing the financial stress and risk on only one member. In Round 2 PD activities, co-designers appreciated this new design and felt that the steps were intuitive to understand and operate, which they believed could effectively increase the ease of use of splitting shared bills to further ensure fairness.

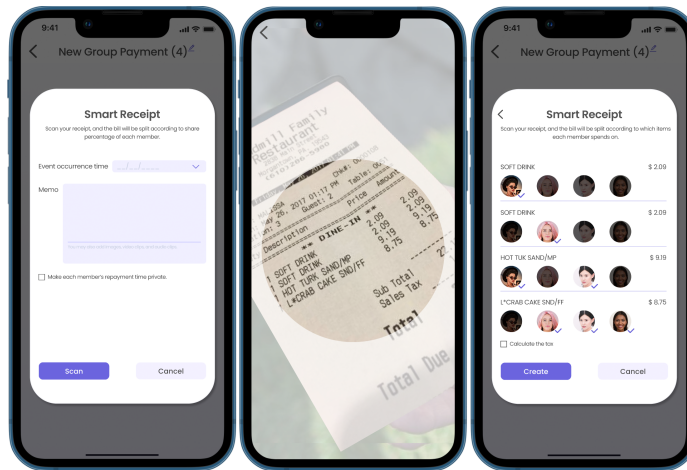


Figure 7.7: People can easily split bills by scanning their receipt and only select items they need to pay.

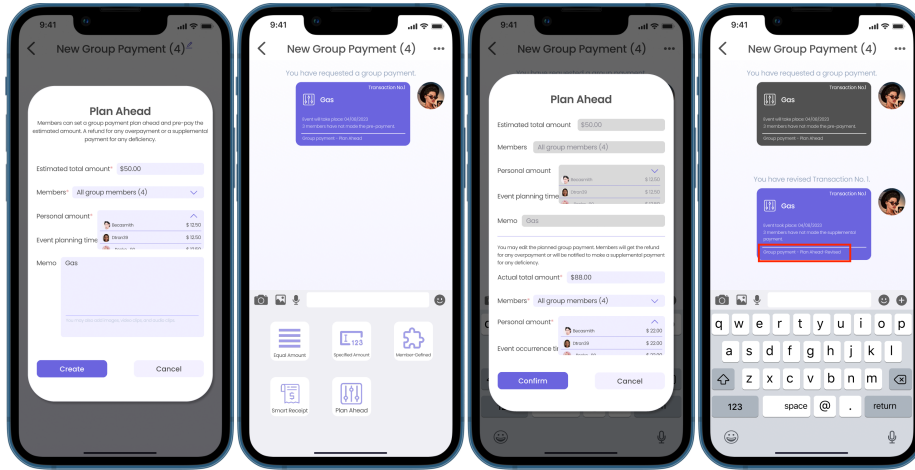


Figure 7.8: People can set up “Plan Ahead” and revisit it to edit the amount they actually spent.

### 7.3.3 Focus 3: Understanding and Designing for Decreasing Peer Pressure

We identified two design themes regarding decreasing peer pressure while making personal money transaction with known contacts via digital P2P payments to help facilitate existing offline interpersonal relationships. In particular, these designs mainly focus on how to make people more willing to use digital P2P payments rather than being forced to use due to peer pressure.

**1. Digital P2P payments services should focus on increasing people’s interests in and willingness of usage:** As shown in our previous findings, one of the reasons why some people were not willing to use digital P2P payments is that they did not want to download the apps. Co-designers shared similar concerns and tried to solve this issue by making digital P2P payments services more attractive and appealing to increase people’s interests and willingness in adopting this payment method. For example, strong incentives may motivate people to adopt digital P2P payments, which may include earning points from making transactions or donations via the very app. In Round 2 PD activities, co-designers further specified that users can be provided with more diverse ways to be benefited from the earned points, such as redeeming rewards by using points or offsetting part of the amount of their transactions (see Fig 7.9).

**2. Digital P2P payments services should emphasize personal privacy:** Also, as shown in our previous findings, another reason why some people did not adopt digital P2P payments is that they did not trust the way to transfer money online with their personal information

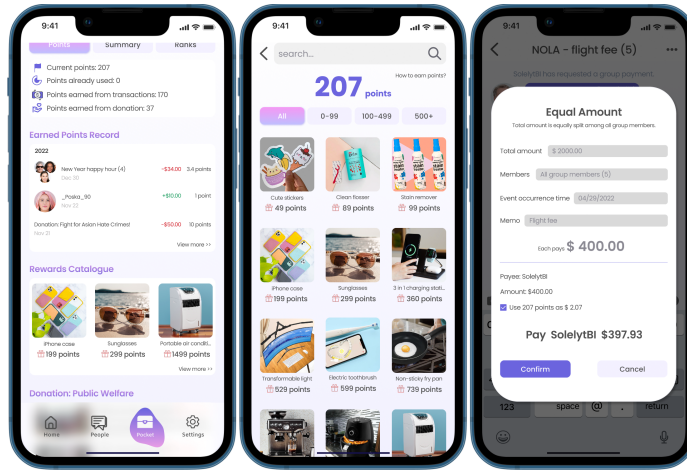


Figure 7.9: People can use points they earned to redeem rewards or offset part of the amount they need to pay in money transactions.

linked, especially for people who do not own smartphones or older adults who are unfamiliar with digital payments. Therefore, digital P2P payments services should emphasize personal privacy. For example, to offer users a feeling of assurance, co-designers suggested that the apps should prompt users to access to specific privacy settings at the first use.

### 7.3.4 Focus 4: Understanding and Designing for Increasing Emotion in Communication

We also identified three design themes regarding increasing emotion in communication while making personal money transaction with known contacts via digital P2P payments to help facilitate existing offline interpersonal relationships.

**1. Relationship building should be enhanced:** Co-designers highlighted that future digital P2P payments should focus on enhancing relationship building between known contacts. One potential approach is to increase the possibility of further communication. For example, users could be prompted to send a thank-you note back when receiving gift-giving transactions. They could also use various nuanced ways to express their emotions in notes/memos, including video, audio, text, picture, and so forth (see Fig 7.10). In Round 2 PD activities, co-designers appreciated the prototype design for personalizing their memo. Another potential approach identified by co-designers is to connect money transactions with personal emotional cues, such as allowing users to associate their money transactions with customized ring tones and allowing users to customize their unique

virtual banknotes to further strengthen their existing relationships with senders/recipients.

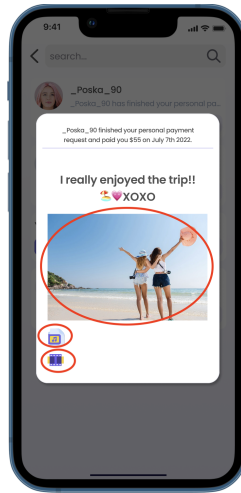


Figure 7.10: People can attach pictures and video/audio clips in the memo when they make personal money transactions.

**2. People should be able to express specific personal feelings for each transaction:** Our previous findings have highlighted that one weakness of digital P2P payments is that they tend to remove the human component from personal money transactions that are in essence interactive social activities. By replacing face-to-face money transactions (e.g., handing over cash) with remote instant transactions, people may also lose the valuable contextual cues and emotional expressions that are often involved in fact-to-face money transactions with their known contacts. Therefore, co-designers suggested that future digital P2P payments services should allow users to express specific personal emotions for each transaction, which would allow senders/recipients to unpack contextual cues and feelings associated with the said transaction. For instance, smiley face, medium face, and sad face can be added to each transaction to let users express how they feel about the transaction; more emojis or selfie feature can be included in memos/notes for users to express their emotions more clearly and accurately at the moment.

**3. Digital P2P payments services should simulate the sense of physicality of face-to-face cash transactions:** Similar to our previous studies, our co-designers also valued the sense of physicality in face-to-face cash transactions (e.g., handing over physical money). Therefore, they suggested that designing digital P2P payments services to simulate the sense of physicality involved in face-to-face cash transactions would help better convey people's emotions embedded in money transactions. To achieve this goal, they designed several features that simulate people's habits

of making face-to-face cash transaction offline, such as using physicalized virtual representations of number instead of only typing one number (e.g., instead of typing \$50, people would select ten 5



Figure 7.11: Using AR to simulate the sense of physicality of face-to-face cash transactions via digital P2P payments.

dollar bills); simulating the process of handing over cash by using AR (Figure 7.11); or generating a vibration of user’s digital device to simulating a hug when completing a transaction. In Round 2 PD activities, co-designers believed that this prototype design has potential to increase digital P2P payments users’ awareness of the physical nature of the money transaction process, which may help them emotionally connect themselves more to the sender/recipient of such money transactions.

## 7.4 Discussion

Using the research through design approach, in this study, we were able to understand the underlying needs of digital P2P payments users and how digital P2P payments can be redesigned to better support their offline interpersonal relationships. Through two rounds of PD activities, we iteratively improved design solutions generated by co-designers to better address digital P2P payments users’ needs for social connections when they make personal money transactions. We especially found that co-designers’ primary design concepts for redesigning digital P2P payments for social connections focused on solving immediate social consequences: further reducing awkwardness, easily ensuring fairness, decreasing peer pressure, and increasing emotions in communication. Table 7.2 summarizes our main findings. In this section, we further reflect upon the implications of our

Focuses	Design Themes	Example Solutions	Notes
Understanding and designing for reducing awkwardness	<ul style="list-style-type: none"> <li>There should not be dispute or ambiguity about shared activities and shared bills.</li> <li>There should be no need to remind others of shared bills in a personal way.</li> </ul>	1. Create the record of shared events and add people who also participated in the same event.	From selected design ideas
		<ol style="list-style-type: none"> <li>Notify involved ones for possible transfers from the system when the record of shared events is created.</li> <li>Set up money-requests different urgency levels to notify people to repay.</li> <li>Notify other involved users to split the shared bill from the system if detecting a large amount of money is being charged.</li> </ol>	From selected design ideas
	<ul style="list-style-type: none"> <li>Making personal money transactions should be more fun</li> </ul>	<ol style="list-style-type: none"> <li>Allow to customize banknotes into different shapes as users may fold paper money in real world.</li> <li>Associate transactions whether it's being charged, paid, or spending with more interesting and cool sounds.</li> </ol>	From selected design ideas
	<ul style="list-style-type: none"> <li>Digital P2P payments should be designed to encourage people to complete money transactions fast and in time.</li> </ul>	<ol style="list-style-type: none"> <li>Get better rewards when users have a good response rate (to completing transactions).</li> <li>Imitate FICO score for setting trust scores based on how fast users are able to pay the requested money or if users are bale to pay the requested money within a certain period.</li> <li>Provide the app-wide trust rank based on response rate.</li> <li>Provide the most frequently used group payment chat rooms as well as users people have the most frequent transactions with as shortcuts to locate senders/recipients.</li> </ol>	From selected design ideas From selected design ideas
Understanding and designing for ensuring fairness	<ul style="list-style-type: none"> <li>Digital P2P payments should provide more nuanced ways to split bills.</li> </ul>	<ol style="list-style-type: none"> <li>Allow 'shadow pay' to secretly repay people without notifying them especially when people try to be generous to offer a treat.</li> <li>Set an ad-hoc group payment (chat room) for shared bills, which will naturally and automatically divvy out charges to group members according to different function settings, such as evenly splitting bills, specifying specific amount for each member, planning ahead, setting spending cap, etc.</li> <li>Create a 'member-defined amount' in the group payment (chat room) to allow members to determine and enter the payment amount by themselves.</li> </ol>	From selected design ideas From selected design ideas
		<ol style="list-style-type: none"> <li>Create a 'specified amount' in the group payment (chat room) for the payer to specify the amount of each member according to how much each of them spends.</li> <li>Create a 'plan ahead' in the group payment (chat room) to pre-pay the estimated amount of the planned event from all members' accounts. A refund for any overpayment or a supplemental payment for any deficiency after the event.</li> <li>Create a 'smart receipt' in the group payment (chat room) and scan the receipt and the bill will be split according to which items each member spends on.</li> <li>As people need to make transactions with known contacts many times, both parties agree to put some of the transaction money in a pre-designated "Mutual Fund" if the sender and recipient need to use the money for future shared activities such as going get coffee, trips, etc.</li> </ol>	From selected design ideas From selected design ideas
		<ol style="list-style-type: none"> <li>Get rewards from each transaction or donation via the very P2P app.</li> <li>Allow various ways to redeem rewards: use points earned to offset transaction amount, to redeem catalogue items.</li> </ol>	From selected design ideas
Understanding and designing for decreasing peer pressure	<ul style="list-style-type: none"> <li>Digital P2P payments services should focus on increasing people's interests and willingness of usage.</li> <li>Digital P2P payments services should emphasize personal privacy.</li> </ul>	<ol style="list-style-type: none"> <li>Prompt people to access to specific privacy settings at the first use.</li> </ol>	From selected design ideas
		<ol style="list-style-type: none"> <li>Prompt people for further communication, like sending thank-you note back.</li> <li>Enrich ways that notes/memos express people's nuanced emotion, such as video, audio, text, picture, etc.</li> <li>Add animation like confetti when completing transactions.</li> <li>Allow to customize images of banknotes.</li> </ol>	From selected design ideas
Understanding and designing for increasing emotion in communication	<ul style="list-style-type: none"> <li>Relationship building should be enhanced.</li> <li>People should be able to express specific personal feelings for each transaction.</li> <li>Digital P2P payments services should simulate the sense of physicality of face-to-face cash transactions.</li> </ul>	<ol style="list-style-type: none"> <li>Set different emotion faces to show how the transaction makes users feel.</li> <li>Add more emojis or selfie feature for memos/notes.</li> </ol>	From selected design ideas
		<ol style="list-style-type: none"> <li>Allow to break a higher denomination. For example, instead of typing \$50, select ten 5 dollars.</li> <li>Simulate the process of handing over cash by using AR.</li> <li>Come with a vibration of people's smartphone like simulating a hug when paying or receiving money.</li> </ol>	From selected design ideas

Table 7.2: Summary of key findings.

research through design approach and our PD activities for helping us gain new knowledge of how digital P2P payments systems can be redesigned to better support people’s social connections.

#### **7.4.1 A Reflection on the Research through Design Approach and PD Process**

As we adopted a research through design approach in Study 4, it is important to reflect upon how this approach and our PD activities worked to actively involve digital P2P payments users in our design process. Overall, we found that the research through design approach and PD process were especially valuable for generating new knowledge of how digital P2P payments systems can be redesigned to better support people’s social connections in two ways.

First, one of the most essential elements of our PD activities, ideation, was to generate solutions of features or functions of digital P2P payment apps one could use or experience to benefit their existing interpersonal relationships. This is where the research through design approach and PD process can be particularly beneficial, as it allows researchers to gather insights and feedback directly from users [193]. Previous research has shown that involving users in the design process can lead to more effective solutions that better meet user needs and preferences, especially for designing practical digital applications [55, 85, 163, 218]. In Study 4, by involving actual users as co-designers in the ideation process and using their lived experiences as a resource, we were able to both better understand their actual social needs and experiences with existing digital P2P payments services and generate potential usage scenarios and innovative solutions grounded in people’s actual experiences and expectations/envisions.

Second, the unique value of the research through design approach and PD process lies in offering actual users an opportunity to witness and review how their ideas and concepts could play out in practice [6, 84]. As shown in our results, this unique opportunity encouraged co-designers to reconsider how their seemingly unrealistic suggestions from the first round could be made more feasible and tangible from a design perspective. This unique opportunity also allowed us to directly engage with actual users to examine to what extent our prototype and design conform with the users’ ultimate goal for supporting their social connections through using digital P2P payments. Further, such retrospective discussion for improvement became a key way to ensure the quality of our final outcomes, as it allows the co-designers to reflect and rethink the feasibility of their design



suggestions.

However, we also identified potential challenges and lessons of using the Research through design approach and PD activities to redesign digital P2P payments for social connections. One of the main challenges we faced was to ensure that co-designers stay focused on the task at hand. As Svanaes et al. discussed, one of the trade-offs of PD activities is the difficulty to guide the users in their creative processes [219]. In our study, we also realized that it was crucial to achieve a balance between co-designers' active engagement in the research and design process and focusing on our particular research goal (i.e., both elicit and qualitatively investigate user needs and user-generated design solutions for digital P2P payment services that can better support people's social connections). Grounded in our own reflections upon our research through design approach and PD activities, we suggest that an appropriate balance can be achieved by: (1) clearly stating the intended goal of the PD activities at the very beginning; (2) providing the participants with the necessary information and guidance to carry out their work; and (3) directly intervening if participants lose track of the main research and design goals. While this may be relevant for all PD activities, it is particularly important to keep co-designers focused on the overall research and design goal and stay on the right track related to this goal in the ideation and brainstorming process.

#### **7.4.2 A Reflection on User-Generated Recommendations to Redesign Digital P2P Payments to Facilitate Offline Interpersonal Relationships.**

As Study 1 to 3 have shown, the process of exchanging money can be awkward and uncomfortable for some people, especially between known contacts. This may also lead to hesitation in adopting digital P2P payment apps, which can be exacerbated by peer pressure and concerns over perceived fairness. In Study 4, our co-designers have also highlighted these challenges and proposed potential design suggestions to both promote positive consequences and impacts (e.g., reduce more awkwardness, relieving more tension) and mitigate negative consequences and impacts (e.g., increasing emotion in communication) of using digital P2P payments within people already know each other. Their recommendations thus focused on all four immediate social consequences of digital P2P payments' influences on existing social connections that we have identified in previous studies. In this section, we further discuss and reflect upon these user-generated recommendations

to redesign digital P2P payments to facilitate offline interpersonal relationships.

One of the key findings of Study 4 is that co-designers tended to look for ways to make personal money transaction process less awkward from five aspects, including settlement of disputes, avoiding personal reminders, making the transaction process fun, encouraging people to complete money transactions fast and in time, and providing more nuanced ways to split bills. Another important consideration is the issue of fairness, as many people are concerned about the potential for unequal exchanges, unnecessary responsibility, and misunderstandings regarding money between their known contacts. Co-designers have responded to these concerns by creating more transparent and standardized payment features that effectively streamline the shared bill splitting for various situations and reduce personal involvement that may cause chaos and confusion.

In addition, co-designers have been exploring new ways to reduce peer pressure surrounding adopting digital P2P payments. This can be achieved through a variety of design and marketing strategies, such as allowing users to easily control and access to their privacy settings or providing strong incentives and rewards pyramid. Lastly, co-designers have recognized the importance of communicating rich emotions in the digital P2P payment process and have been exploring ways to increase the emotional resonance of personal money transactions to enhance connections and maintain existing relationships. For them, this can be achieved through design solutions such as incorporating personalized messaging or using various visual and audio cues to enhance the emotional impact of the exchange.

However, as HCC/HCI researcher, we also offer a critical view of some of the user-generated recommendations to redesign digital P2P payments, as they might actually come across as potentially risky for social connections rather than supporting people's existing interpersonal relationships.

For example, we acknowledge that introducing the mechanism of trust scores based on how quickly people respond to money requests and providing app-wide trust rank according to the scores may have certain potential benefits as our co-designers suggested. Yet, it should be noted that this potential design needs to be carefully considered. First, only using response time as a measure for trustworthiness assumes that people who respond quickly are more reliable and responsible than those who do not. In reality, this may not always be the case, as some people may prioritize certain payments over others, or they may encounter unexpected circumstances that prevent them from responding promptly. In our PD activities, co-designers suggested that this design feature could imitate FICO scores. While FICO does not reveal its scoring formula, it indeed reveals

comprehensive guidelines about the most factors for such scores, such as payment history, amount of debt relative to credit limits, age of credit, recent applications for credit, and whether people have more than one type of credit [156]. Therefore, similar to FICO score, even if we hope to adopt the mechanism of trust score in future digital P2P payments services, it should require a carefully and reasonably designed formula to accurately produce such scores due to how sensitive these scores and rankings may be perceived (e.g., ranking how each friend is trustworthy when money is involved).

Second, our co-designers believed that implementing such a mechanism may encourage people to complete their payment requests as soon as possible so that they can get a satisfactory trust score or be top ranked within their friend circle. However, the design could potentially increase the already high peer pressure associated with using digital P2P payments. For instance, the scoring and ranking system may create a sense of urgency and obligation for people to respond quickly, even if they may not be able to do so at that moment due to various reasons. Additionally, some people may feel anxious or stressed about maintaining a good score and high trust rank, especially among their friend groups.

Third, it is important to consider the potential biases and privacy concerns that may arise from this type of trust rank system. People who have greater financial stability may be more likely to respond to payment requests quickly while those without such financial status may struggle to do so. There might also be potential disputes or misunderstandings between users who feel that their trust score or rank is unfairly affected by circumstances beyond their control, which could impact people's overall experience with the payment platform and their interpersonal relationships with people they know. As a result, introducing this new feature may not only cause significant awkwardness when using digital P2P payments between known contacts but also reinforce certain social and economic inequalities among people's social connections.

In summary, we believe that our research through design approach and PD activities has proven to be effective for (1) directly engaging actual digital P2P payments users in our research and design process; (2) helping us both elicit and qualitatively investigate user needs and user-generated design solutions for digital P2P payment services that can better support people's social connections; and (3) encouraging us to critically reflect upon user-generated recommendations to better understand this novel problem space.

# Chapter 8

## Discussion

Grounded in our findings throughout this entire dissertation research (Study 1 to 4), in this section, we provide a more comprehensive image of understanding and redesigning digital P2P payments for social connections by discussing: (1) how our findings collectively address our research questions in this dissertation research; (2) how the complicated interplay between money transactions, computer-mediated interpersonal relationships, and digital P2P payments may inform future research on the nuanced role of financial technologies in (re)shaping people’s social connections; and (3) the future landscape of digital P2P payments in our increasingly networked digital society.

### 8.1 Addressing RQs

We first discuss how, taken together, our findings through Study 1 to 4 collaboratively address our RQs presented at the beginning of this dissertation.

#### 8.1.1 RQ1: What are the interaction dynamics of using digital P2P payments between people with existing relationships in terms of different modes, usage purposes and contexts, frequency, and recipient/sender?

Based on findings from Study 1, Study 2, and Study 3, we are able to present a more comprehensive understanding of interaction dynamics of using digital P2P payments between known

contacts.

### 1. Modes

*Face-to-face vs. remote:* Our findings show that digital P2P payments support both remote and face-to-face instant transactions. Face-to-face transactions via digital payment apps typically involve two individuals who are physically present with each other and who hope to transfer money directly between their mobile devices. If digital P2P payments are used for face-to-face transactions, such transactions can still happen in an offline context with various social cues (e.g., eye contacts and non-verbal cues) and direct communication between the two known contacts. In contrast to traditional face-to-face payment methods (e.g., physical money, cards, etc), using digital P2P payments for face-to-face transactions has additional benefits of making personal money transactions much quicker, easier, and more conveniently. It could also save personal time and efforts of dealing with cash, cards, or checks as well as intentionally separating social interactions from potentially awkward financial activities (e.g., waiting for the other party to count cash).

If digital P2P payments are used remotely (e.g., between two known contacts who are not physically co-present), such a payment method allows people who know each other to send and receive money from anywhere and at any time, making it a convenient option for remote transactions. Unlike face-to-face transactions, remote transactions via digital P2P payments lack direct communication channels for socio-emotional and nonverbal cues. Therefore, many participants need to confirm recipients' user accounts or identity information several times before conducting personal money transactions to avoid mistakes (e.g., transferring money to the wrong person or account). However, for many cases where people cannot conduct transactions at the moment or meet in person, digital P2P payments allow known contacts to send and receive money immediately and in the moment, which in itself becomes a valuable means of maintaining and improving their existing relationships.

*Synchronous vs. asynchronous:* Our findings also show that people can use digital P2P payments to make transactions either synchronously or asynchronously. For example, synchronous transactions are useful for splitting a bill for a shared expense with people who know each other so that all are able to complete the transaction in time and ensure that the payment is successful. This synchronicity thus avoids extra communication about the transaction afterwards. Asynchronous transactions via digital P2P payments can provide more flexibility, allowing people to respond at their convenience. In this sense, when making personal money transactions with known contacts, senders and recipients can expect to be paid or to pay at a later time that they agree upon. Asynchronous

transactions are particularly useful for recurring payments, such as rent or utility bills and group payments, such as gifts, fundraisers, or other situations where multiple individuals are contributing to a shared payment. However, asynchronous transactions may also introduce potential challenges and interpersonal tensions as it does allow payers to deliberately delay the completion of the transaction. In short, by supporting both synchronous and asynchronous transactions, digital P2P payments give people who know each other more freedom to make transactions based on their own personal needs and social contexts, which facilitates a more nuanced experience of dealing with money to support their social connections.

## **2. Usage Purposes**

Our findings collectively highlight how digital P2P payments have been increasingly integrated into people's everyday life when they deal with money with their known contacts:

1) Splitting bills: digital P2P payments are often used by groups of friends, colleagues, or roommates to split bills for meals, rent, utilities, and other shared expenses;

2) Paying back loans: friends or family members who have lent money to each other can use digital P2P payments to easily settle the debt;

3) Sending gifts or support: digital P2P payments are useful for sending money as a gift, such as Chinese New Year lucky money, a birthday or wedding present, or for making payments to support one's personal care;

4) Sharing expenses: digital P2P payments are often used to share expenses related to events or trips, such as concert tickets or hotel reservations between friends, significant others, among others;

5) Donations: digital P2P payment is also a convenient way to make donations to others people try to support, such as making donation for neighbors or colleagues who are in a difficult situation;

6) Emergency money transfer: digital P2P payment is a quick and easy way to transfer money in emergency situations, such as when a friend or family member needs financial help urgently.

## **3. Frequency**

The frequency of using digital P2P payments between known contacts varies and depends on people's different personal financial needs and preferences. Overall, our findings do show that digital P2P payments have increasingly become a common payment method for making personal money transactions in today's society. For example, our findings show that show that 43.8% of

participants all over the world used digital P2P payments at least once a month. Previous research has also indicated the high engagement. According to a 2022 report focusing on the US consumers (N=3112) by Cornerstone Advisor, 7% of respondents sent daily or almost daily, 25% sent weekly, and 34% sent about once a month [205]. Although the frequency of using digital P2P payments between existing relationships once decreased, this decline was likely a result of the pandemic as fewer people were socializing and thus had fewer opportunities to use digital P2P payments: in 2020, the average frequency of use of P2P services had decreased from 9.0 in 2019 to 8.0 transactions annually [184]. In general, the usage of P2P payment is increasing rapidly, especially among younger generations who are more comfortable with digital technologies [22]. Another more nuanced trend of the frequency of using digital P2P payments emerging from Study 1 to 4 is that young generations use digital P2P payments more frequently than middle age and older adults: 41.4% of participants who were millennials and Gen Z self-reported that they used digital P2P payments at least once a week; but for participants who were Gen X and Baby Boomer, only 23.8% of them used digital P2P payments at least once a week.

#### **4. Recipient/Sender**

When it comes to with whom people usually use digital P2P payments to make personal money transactions, our findings show that recipients or senders of digital P2P payments are often friends, family members, significant others, colleagues, co-workers, neighbors, and other acquaintances. Generally, people tend to adopt digital P2P payments to share bills, repay, or reimburse with friends, colleagues, peers, and others of more equal status. In particular, it is very common for the younger generation to use digital P2P payments for group payments (e.g., gathering money together to host a party) with their friends and peers. Regarding gifting money, supporting others' personal issues, or making donations, people are more likely to use digital P2P payments to make transactions with their family members and significant others. For example, grandparents may send birthday gift-money to their grandchildren who live far away.

Additionally, our findings show that people seem to have varying payment habits, expectations, and perceptions of how personal money transactions should be conducted via digital P2P payments, mainly depending on their relationships with the sender or recipient. For instance, as recipients, people sometimes expect more accurate amount from those who they do not know well or have weak social ties with. They feel reasonable and natural to make precise transactions. Instead, people tend to be more tolerant to those they have closer interpersonal relationships with (e.g., a

good friend), such as being more acceptable with delayed repayments or rounding payments (e.g., accepting \$5 instead of \$5.12). As senders, people also demonstrate similar pattern: many feel comfortable with rounding up the amount when they need to pay others who are closer to them. However, if they are not close with the recipient, they are reluctant to round down the amount even if the amount is extremely close to a whole number (e.g., still pay exactly \$5.02 rather than \$5).

### **8.1.2 RQ2: How do people perceive and experience both positive and negative influences of using digital P2P payments on their interpersonal relationships with people they already know?**

Taken together, our findings show that existing interpersonal relationships can be directly influenced by digital P2P payments in various ways. There are four immediate social consequences of making personal money transactions via digital P2P payments: reduced awkwardness; a stronger sense of fairness; added peer pressure; and decreased emotion in communication. Using digital P2P payments also exerts lasting impacts on people’s existing interpersonal relationship: promoting trusts; relieving potential tensions; and weakening the emotional attachment to the sender/recipient.

#### **8.1.2.1 Positive Immediate Social Consequences**

Compared to using traditional payment methods (e.g., physical money), our findings show that people tend to experience less awkwardness from using digital P2P payments when making money transactions with known contacts. Digital P2P payments enable people to make instant transactions in the moment to reduce delayed payments, offer a less personal and more neutral way to communicate finance-related information with existing relationships, and develop an easy access to transaction records to avoid potential arguments and disputes. Yet, it should be noted that when using specific digital P2P payment apps - social payment apps (e.g., Facebook Messenger Pay), perceived awkwardness may rise as people are not comfortable with all-in-one design of integrating financial interaction into sociability and communication-centric platforms. Such integration may lead to potential tensions and undesired social consequences (e.g., how to decline a friend’s message to borrow money through Facebook Messenger Pay).

People may experience more fairness from using digital P2P payments when making money transactions with known contacts. First, people are able to make precise transactions with existing



relationships such as easily typing numbers, automatically calculating the correct amount of money owed, and so forth. This can help prevent errors, shortage of repayment, or discrepancies that might occur with other payment methods. Second, people do not need to take the risk of paying the whole group bill up front. Instead, the pressure can be fairly shared by every group member who are responsible of paying the bill.

#### **8.1.2.2 Negative Immediate Social Consequences**

Despite these benefits, people can feel more peer pressure when using digital P2P payments to making money transactions with people they know. Such influence mainly comes from having to use smartphones, being required to download apps, linking private information (e.g., bank accounts) to the app, and being open to mobile payments. As people already know each other, sometimes it is challenging and awkward if one party just refuse to download and use a certain digital P2P payment app when most people in their social group ask them to do so.

As digital P2P payments is a computer-mediated payment method, people may experience less emotions in communication when using digital P2P payments in comparison to using physical money when making money transactions with known contacts. For them, although digital P2P payments allow them to conduct money transactions remotely and quickly, they may also eliminate personal interaction and communication that are often involved in face to face money transactions (e.g., expressing gratitude or best wishes).

#### **8.1.2.3 Positive Lasting Social Impacts**

In the long term, our findings show that using digital P2P payments helps promote trust for existing interpersonal relationships. Due to the immediacy and convenience of digital P2P payments, people are more confident in their personal connections with known contacts as there is no room for arguments or misunderstandings of finance-related activities. In particular, digital P2P payments can help curb the possibility of distrust caused by money (e.g., forgetting to pay) and reduce cognitive load (e.g., remembering to pay) when dealing with money with known contacts. This makes it easier to build and foster friendships, because both parties involved can maintain a healthy, positive, and sustainable attitude towards a traditionally sensitive topic - dealing with money between friends.

In addition, people may experience less interpersonal tension when they make money transactions with known contacts using digital P2P payments than using physical money. On the one

hand, using digital P2P payments to make instant transactions effectively loosens both the financial stress and social pressure on maintaining a friendship. For example, one can get his/her money back in the moment without waiting for a long while to get reimbursement or repayment from their friends and then will not feel more anxious about socializing with the friends. On the other hand, using digital P2P payments allows people to focus more on social activities and interactions that foster interpersonal relationships and avoid potential confrontation (e.g., conflicts due to different payment habits) rather than being too concerned about money issues. In doing so, digital P2P payments seem to be a valuable technology to ease potential tensions and conflicts between known contacts when money is involved, which would benefit people's interpersonal relationships in the long term.

#### **8.1.2.4 Negative Lasting Social Impacts?**

Our findings also show that in the long terms, using digital P2P payments might weaken people's emotional attachment to senders/recipients they already know. Although this effect is not significant from a quantitative perspective, there is concern that over-relying on such a computer-mediated payment method may reduce the feelings of closeness or affection, which weakens the emotional attachment over time. In particular, when the usage context of digital P2P payments is culturally sensitive, it is important to allow personal interaction and emotional communication in the money transaction process. For example, the sense of ritual and rich cultural implications (e.g., the older generation's best wishes for the younger generation) buried in handing over Chinese New Year lucky money in person is mostly lost if the money gifting is only made via digital P2P payments.

While this can be seen as a negative lasting social impact to some, it should also be noted that some other users also provide a counter example: For some people who try to maintain long-distance relationships, using digital P2P payments may actually help strengthen the emotional attachment to their known contacts beyond time and geographical limits.

### 8.1.3 RQ3: How can future digital P2P payments systems be designed to better support people’s social connections with individuals they know?

Synthesizing our findings across all 4 studies, we have identified three main design directions that may inform the future design of digital P2P payments services to support existing interpersonal relationships: adding more nuances to money transactions through technology, making digital P2P payments more accessible and easier to adopt, and further reinforcing personal interaction and communication in money transactions through digital P2P payments.

**Adding More Nuances to Money Transactions through Technology.** To further leverage the unique instantaneity and convenience of digital P2P payments to reduce awkwardness, promote trust, and relieve tensions, our findings have highlighted the focus on making money transactions between known contacts faster, smoother, and more flexible to support more nuanced and complex social situations and relationships. For example, having the summary and record of joint participated events and shared bills can help eliminate dispute and arguments; automated reminders can avoid unnecessary and unwanted social interactions; flexible transaction options (e.g., evenly split-bills, scheduled ahead group payment, etc) can allow users to easily and smoothly deal with various finance-related events; adding more enjoyment and fun to money transactions helps make P2P payments less awkward.

**Making Digital P2P Payments More Accessible and Easier to Adopt.** To ease peer pressure of using digital P2P payments, our findings also point out that increasing its adoption and usage is the key. It is critical that the new financial technology should not introduce new doubts or concerns that may harm rather than promote people’s existing social connections. Instead, people should feel more confident and comfortable to use digital P2P payments with their known contacts. In this sense, digital P2P payment apps should provide more accessibility, higher security, and stronger incentives to encourage potential users to be open to using it. Specific suggestions include easy onboarding process to learn how to use the app, interoperability between different P2P payment platforms, compatibility with all kinds of operating systems, supporting offline transactions without Internet connections, among others.

**Further Reinforcing Personal Interaction and Communication in money transactions through Digital P2P Payments.** Collectively, our studies further highlight the critical

need for reinforcing personal interaction and communication in making money transactions with known contacts, such as enhancing social and cultural relevance by taking local cultural values into account, framing financial transactions as social experiences, and enriching the ways users can express and convey specific emotions and feelings through the app. Grounded in our findings, this focus is crucial to maintain both (1) various benefits and strengths of using digital P2P payments for more efficient and convenient money transactions between known contacts to avoid potential misunderstandings and tensions regarding money; and (2) the unique sense of emotional expression and personal attachment that is often involved in face to face offline money transactions.

## **8.2 Revisiting Money Transactions, Computer-Mediated Interpersonal Relationships, and Digital P2P Payments**

Since the late 1990s, various financial technologies, including online banking services, online payments, and e-commerce have gradually been embedded in every aspect of people's daily lives. Today, the rise of digital P2P payments has undoubtedly shaped how individuals exchange money with people know, as we have shown in this dissertation. However, how using digital P2P payments actually affect people's interpersonal relationships is still understudied, as this dissertation research also reflects various discrepancies in the influences of digital P2P payments on people's existing interpersonal relationships. Therefore, we consider it necessary and important to reexamine the complicated relationships between money transactions, computer-mediated interpersonal relationships, and digital P2P payments, which may inform future research on the nuanced role of financial technologies in (re)shaping people's social connections.

### **8.2.1 New Perspectives of Computer-Mediated Interpersonal Relationships through Digital P2P Payments**

In contrast to previous studies that focus on digital P2P payments users' online social patterns [1, 2, 227, 255], our findings highlight that using digital P2P payment serves as a double-edged sword for people's offline interpersonal relationships. This thus provides new perspectives of how novel financial technologies such as digital P2P payments extend and (re)shape computer-mediated interpersonal relationships.

As we have shown, digital P2P payments facilitate effective and accurate financial exchanges from which people reap benefits of their precision, rapidness and convenience. Such timeliness, simplicity, and fairness may also help promote interpersonal relationships involved in these money transactions by increasing trust and relieving potential tensions. However, meanwhile the important social clues and emotions in traditional financial patterns are also eliminated, which makes such transactions all about money transfer but less about people themselves. And then emotional attachment to existing relationships may become weaker over time. As some of our participants have highlighted, the context of the money transaction, relationships with people who are involved in the transaction, and the emotions associated with the transaction are more important to them than the transaction and money itself. Previous studies have suggested that there tends to be less social affection, less communication of intimate feelings, and more detachment when engaging in computer-mediated money transactions [112, 185, 187]. As a result, P2P digital payments users may become less emotionally involved with each other, which gradually undermines their interpersonal relationships.

This may be one reason why our participants considered paying the exact amount owed via digital P2P payments negative, petty, and annoying, which is consistent with previous studies [103]. In this sense, payment behaviors through digital P2P payment apps are also social behaviors, which are examined by the hidden rules of interpersonal communication [214]. Such money transactions directly influence people's impressions of each other and how they perceive and manage interpersonal relationships because people believe that how one deals with money reflects his/her personality and behavioral patterns. In turn, one's payment behavior and manners are based on his/her perceptions of the other side of the transaction and the relationship. It is worth noting that some participants' use of digital P2P payment also depends on the closeness of their relationship with the other party. If the other party whom they are interacting with in a money transaction is just an acquaintance or someone who they do not know well, they feel reasonable to make precise transactions. In contrast, if they have a close relationship with the other party (e.g., as good friends), they usually round up the amount when paying to the person or round down when the person needs to pay back without negative feelings.

In summary, such wrestle suggests the importance of the complex interplay of money transactions and offline interpersonal relationships when perceiving and understanding computer-mediated interpersonal relationships. While existing studies on computer-mediated interpersonal relationships

tend to focus on relationships formed, maintained, or fade in diverse online social spaces such as social networking sites [31, 47, 120], online dating sites and applications [224, 262], and forums (e.g., [59, 174]) through communication affordance (e.g., textual chat), this study points to a clear need for taking contexts and activities beyond just social networking platforms and computer-mediated communication modalities (e.g., exchanging money) when investigating how people build and foster such relationships in today’s digital society.

## **8.2.2 (Re)shaping Existing Interpersonal Relationships through Digital P2P Payments**

“Ninety percent of the things we need to navigate in our financial lives are not terribly complicated. The complicated pieces are in the emotional and behavioral element of it,” says Amanda Clayman, a renowned financial therapist. Indeed, our results show that using physical money or using digital P2P payments for money transactions between known people exhibit significant differences in terms of various emotional and behavioral related factors. In this sense, digital P2P payments has become a new and nuanced approach for people to build, perceive, and maintain relationships with each other in today’s networked society, which is actively reconstructing how we deal with money regarding payment scenarios, methods, and social networks compared to traditional payment approaches such as physical money. In this sense, our work expands the growing research agenda in HCI and HCC on the impacts of new financial technologies and technology-mediated money transactions on people’s everyday lives [16, 99, 114]. We particularly highlight the importance of (1) technology-supported strategies to better deal with money in interpersonal relationships; and (2) understanding the trade-offs between reducing interpersonal conflicts and distancing interpersonal closeness via digital P2P Payments.

### **8.2.2.1 Technology-Supported Strategies to Better Deal with Money in Interpersonal Relationships**

Money has long been considered a sensitive subject and even a culturally taboo in various types of interpersonal relationships [125]. For example, it can be one of the main sources of conflicts for marital couples [86, 147, 215], ranging from how couples negotiate each other’s cultural financial discourses [188], responses to romantic partners’ financial decisions [166], to financial infidelity

[72]. It can be a relational struggle for family members and friends. Examples include obfuscatory relational work to refuse lending friends and kins [241], a heavy focus on finances within friendships that may have detrimental effects and even ruin a friendship [139], and financial discrepancies that may lead to unwanted conversations between friends [119]. It may even become a taboo in the workspace. For instance, learning relative-pay/pay disparity from coworkers has the potential to evoke discontent and resentment, thus making a work atmosphere socially awkward or unpleasant and breaking down social cohesion and cooperation [30]. In particular, traditional payment methods via physical money may further amplify the sense of awkwardness and sensitivity when people deal with money in their interpersonal relationships, such as using coins to pay the exact amount, having long discussions to settle the shared bill, and chasing friends to pay back.

Therefore, there seems to be an urgent need for new strategies and methods to help people better deal with money without jeopardizing or ruining their existing interpersonal relationships. Following this call, our study has shown how digital P2P payments may provide a potential solution by leveraging new financial technologies. Through a computer-mediated method, digital P2P payments help people avoid socially awkward face-to-face situations when they have to deal with money with people they know.

Our results indicate that digital P2P payments largely reduce awkwardness in money transactions to facilitate positive experiences of social interactions when money is involved, which helps maintain sustainable and healthy interpersonal relationships by promoting trust and relieving tensions. In this sense, digital P2P payments seem to offer a strategy to effectively separate financial responsibilities (e.g., remembering to repay and the need to carry sufficient cash [88]) from social responsibilities (e.g., maintaining existing interpersonal relationships) in people's everyday lives by moving money transactions to a separate online platform (rather than mingling such transactions with their offline social interactions), guaranteeing instant access to receiving/sending money at any moment, and automatic documentation of such money transaction activities. As a result, people seem to be able to tone down the sensitive and awkward role of "money" in their offline social lives and focus on maintaining personal relationships *per se*.

### **8.2.2.2 Understanding the Trade-Offs between Reducing Interpersonal Conflicts and Distancing Interpersonal Closeness via Digital P2P Payments**

While we acknowledge that digital P2P payments may offer new and effective technology-supported strategies for people to better deal with money in their interpersonal relationships, it is also important to highlight the potential trade-offs between how such computer-mediated payment methods both potentially reduce interpersonal conflicts and distance interpersonal closeness when dealing with money.

Above all, digital P2P payments allow users to make money transactions remotely beyond distance. Previous research has argued that computer-mediated communication in a remote mode can be challenging for people because it lacks physical presence and nonverbal elements [23]. The lack of social cues in such computer-mediated communication methods may also lead to the feeling of emotional detachment [4, 192]. Indeed, our study has confirmed a certain degree of loss of emotion in interpersonal money transactions via digital P2P payments and a relatively weaker emotional attachment to people involved in these transactions, despite their established interpersonal relationships.

In this sense, digital P2P payments seem to introduce a social dilemma. On the one hand, as described in the previous section, they set up a fine line between maintaining social connections offline and dealing with money online, which ensures a sense of fairness and neutrality in financial activities between known contacts [7]. On the other hand, by moving money transactions to a remote and computer-mediated mode without face-to-face interactions, they also risk losing rich social information and expressions of emotions that are often involved in money transactions between known contacts (e.g., gifting, celebrating, and showing support). As a result, they may in fact weaken people's established interpersonal relationships as they tend to reduce the social and emotional implications of money transactions, which makes such transactions merely financial activities rather than social activities. Therefore, how to maximize digital P2P payments' benefits for reducing interpersonal conflicts and mitigating their weakness of lacking rich social and emotional expressions when dealing with money should become an important consideration for designing more supportive and socially satisfactory digital P2P payment platforms in the future.



### **8.2.3 Reflections on Potential New Research Directions to Further Unpack the Unique Role of Digital P2P Payments in Existing Interpersonal Relationships**

Taken together, our findings have shown the complex influences of digital P2P payments on existing interpersonal relationships and the need for more research to further explore how novel payment methods such as digital P2P payments continue to change the way people think about and approach money transactions and the social dynamics embedded in these financial interactions. Therefore, we highlight our reflections on several potential new research directions to further unpack the unique role of digital P2P payments in existing interpersonal relationships.

**Reflection 1: How would digital P2P payments lead to immediate social consequences and lasting impacts on interpersonal relationships with known contacts across various genders, ages, status (e.g., financial situations and residence), and cultural backgrounds?**

The reason behind why digital P2P payments can affect our interpersonal relationships with known contacts may lie in the changes in social behavior and social norms that result from the adoption of the new payment method. When users are in different gender and status, from different age groups and cultural backgrounds, it is unclear how using digital P2P payments may affect the social norms and life patterns to them in a similar or different way. This thus leads to our first reflection: How would digital P2P payments lead to immediate social consequences and lasting impacts on interpersonal relationships with known contacts across various genders, ages, status (e.g., financial situations and residence), and cultural backgrounds?

For example, in this dissertation research, older adults typically tend to be more reluctant to adopt digital P2P payments [42, 131, 250]. Some participants who are Gen X and Baby Boomers also further explained their concerns, such as being cautious about adopting digital payments and their preference to cover bills on their own instead of splitting with known contacts. Therefore, using digital P2P payments can be a burden to them, which may hinder rather than support their existing relationships with others.

In addition, people with different cultural backgrounds may perceive the use of digital P2P payments in their social lives differently. Attitudes towards money transactions with known contacts such as splitting bills and paying for their friends' food can vary widely depending on the cultural

backgrounds of the individuals involved. Dion et al. argued that in individualistic cultures, such as those in North America and Western Europe, there is a greater emphasis on personal autonomy and independence, while in collectivist cultures, such as those in Asia and the Middle East, there is a greater emphasis on group harmony and interdependence [60]. For instance, people do not have to worry about awkwardness over splitting bills in Iceland – it is a completely acceptable practice [203]. It is also considered polite to split bills in Norway as Norwegians prefer not to feel indebted to anyone [177]. However, it is less uncommon to split bills in countries such as Vietnam, Lebanon, Iran, and Mexico [203]. In these cultures, people do not expect their friends to pay the money back despite the convenience of digital P2P payments and they tend to consider “not paying back” an important signal of trust and a necessary way to maintain a friendship. Likewise, in Chinese culture, it is often considered impolite for a group of diners to even contemplate the idea of splitting bills. Instead, the default social norm is that the host should offer to pay for the entire bill, or people would take turns to pay the entire bill at such social gatherings [106].

Our Asian/Indian participant also confirmed with the social norm in his culture that his father, as the head of the family, would always pay for the entire bill rather than asking people to split the bill. Instead of leveraging digital P2P payments’ convenience for reducing awkwardness when splitting bills, in these situations people may choose not to use digital P2P payments at all, simply because they do not have such needs (e.g., splitting a dinner bill). Therefore, to people with such cultural expectations, using digital P2P payments may be considered as distrust and a violation of their underlying social norms when money is involved between known contacts. Likewise, according to the Forbes Advisor survey, nearly 40% of young adult users believed they have been charged a petty amount by a fellow bill-splitter and 86% of digital P2P payments users agreed that anything under \$5 is petty and should not be requested [61]. In this sense, while using digital P2P payments to split bill is convenient, it also conflicts with certain underlying social norms and may intensify the tensions between known contacts.

Lastly, there seems to be a concern that using digital P2P payments may potentially exacerbate economic inequality. While digital P2P payments is a convenient way to transfer money between individuals, they may also reinforce existing economic disparities. For example, if someone does not have a smartphone or cannot afford a stable internet connection, they may not be able to use digital P2P payment apps. This can create a barrier for these individuals to participate in the digital economy and further marginalize already vulnerable populations (e.g., feeling embarrassed in

their social groups because they could not afford to use digital P2P payments). In this sense, rather than reducing awkwardness in money transactions, using digital P2P payments may actually cause more awkwardness instead. Although it is unclear now about how these nuances can actually change our findings, it is important to consider these factors when examining the influence of digital P2P payments on shaping computer-mediated relationships with more cultural awareness and sensitivity.

**Reflection 2: How would the different types of digital P2P payments lead to more nuanced and unique immediate social consequences and lasting impacts on existing interpersonal relationships?**

At the beginning of this dissertation, we have highlighted four main types of digital P2P payments that all support instant personal money transactions [26]. However, the discrepancies among these four types make them each show their own specific strengths and weaknesses in different situations [96, 190, 261] to positively or negatively affect people's existing interpersonal relationships. This thus motivates us to reflect upon if a specific digital P2P payment app/service may result in more nuanced and unique immediate social consequences and lasting impacts on people's existing interpersonal relationships.

First, while standalone P2P payment apps such as Venmo, Cash App, PayPal are trusted and used by tens of millions of users, our findings note that the biggest limit of these well-established digital P2P payments services is that both the sender and the recipient are required to use the same app to make the transaction happen. Participants who got used to certain standalone P2P payment apps in our research also complained that sometimes they were forced to switch to a new app by their peers. In this sense, the need for using a different type of digital P2P payments apps or even discussing whether people need to use a different type of digital P2P payments can create tensions between known contacts.

Second, previous research has explored various aspects of social media and instant messaging apps with built-in payment functions in user adoption [144], security [152], convenience and integration [152], business opportunities [130, 150], and regulation [10, 93, 123]. Our findings confirm the complication of integrating digital P2P payments with established social media and instant messaging platforms. For example, Facebook Messenger Pay may cause more interpersonal tensions due to the mix of sensitive financial activities and social interactions that include with both strong and weak social ties [115]. WeChat Pay, in contrast, may help facilitate more emotion in communication and strengthen the emotional attachment between senders and recipients as it is embedded in

traditional Chinese culture and Chinese people’s money behaviors [245, 248]. Meta Pay in Instagram may also help enhance personal emotion expression and communication, such as donating to content creators to express more gratitude [143].

**Reflection 3: How can we balance various needs and considerations when designing future digital P2P payments for social connections?**

Our findings present various ways to help enhance positive influences as well as mitigate negative influences that digital P2P payments exert on interpersonal relationships with known contacts. However, it also becomes evident to us that it is important to balance various needs and considerations when designing future digital P2P payments for social connections. In particular, our findings shed light on several trade-offs that need to be taken into consideration:

1) security vs. swiftness/convenience: Digital P2P payment systems must be secure enough to prevent fraud and unauthorized access. User-generated design solutions that highlight security may need extra efforts and steps for people to complete a security check procedure. However, being quick and convenient enough to make personal transactions play an important role to reduce awkwardness, promote trust, and relieve tensions. Striking a balance between security and convenience is critical.

2) emotional vs. impersonal: When people switch to digital P2P payments, the ease and convenience of digital P2P payments can make transactions more impersonal and business-like in nature, reducing the level of intimacy and personal communication between individuals. This can avoid potential awkwardness of engaging too much in finance-related interactions between known contacts. However, a distant and impersonal atmosphere and relationship may not be as fulfilling or satisfying as a more personal and meaningful relationship for people who desire to express their emotions through money transactions. Therefore, balancing emotional and impersonal communication mediated by digital P2P payments is important, especially in situations where people need to obey or maintain social norms and customs, such as exchanging gifts or repaying a personal debt.

3) accessibility vs. complexity: Our findings highlight various design recommendations to improve current digital P2P payments features or create novel ways to benefit people’s social connections, such as group payment and different personalization options (e.g., shapes of banknotes and ring tones). However, more advanced features may also require a more complex interface and a higher learning curve cognitive workload for users to adopt new digital P2P payments services, especially for those who are not tech savvy or unfamiliar with digital P2P payments. In this sense, there

exists a urgent need for achieving a balance between accessibility and complexity when redesigning future digital P2P payments services for social connections, which would ensure that this financial technology is accessible to a wide range of diverse users while also offering various, more nuanced advanced features for those who need them.

### **8.3 Envisioning the Future Landscape of Digital P2P Payments**

Collectively, our findings show that participants expect that future digital P2P payments would not only support secure and private transactions but also further promote nuanced social experiences and interpersonal relationships with their known contacts. Grounded in these insights, in the section, we envision the future landscape of digital P2P payments in our increasingly networked digital society. In particular, we highlight three potential themes for better understanding and envisioning how digital P2P payments may continue to play a growing critical role in people’s social lives in the future.

#### **8.3.1 Integrating Digital Currency for More Accessible and Secured Digital P2P Payments in the Future**

Our findings have shown that digital P2P payments have gained popularity in recent years due to their convenience, ease of use, and instantaneity. They thus play a crucial role in reducing awkwardness, promoting trust, and relieving potential tensions in personal money transactions between known contacts. However, our participants also express their concerns about a trade-off embedded in using digital P2P payments: the speed and convenience of digital P2P payments can come at the cost of personal information privacy and transaction security. For example, participants are worried that digital P2P payment apps usually store users’ personal and financial information, such as bank account information, on their servers. If these servers are breached or hacked, users’ private information could be compromised, putting their financial security at risk. In particular, some digital P2P payment apps may not have the same level of fraud protection or detection technology as traditional financial institutions, leaving users vulnerable and exposed to scams or fraudulent transactions. Although several established security strategies such as two factor authentication (2FA) or

biometric identification systems have potential to be built into digital P2P payments, the time and efforts to go through these extra layers of security might undermine the convenience, ease of use, and swiftness that digital P2P payments feature [235].

To balance the need for swiftness with the need for security, we envision that future digital P2P payment apps must implement more robust security measures without users taking extra steps to complete security check. Additionally, digital P2P payment platforms may need to better educate their users about the risks associated with using digital P2P payments services and provide necessary resources to help them be more aware of such risks and gain related knowledge of how to protect their personal and financial information when using such services. To achieve these goals, we envision that integrating digital currency may lead to more accessible and secured digital P2P payments in the future.

Digital currency (or digital money) refers to any means of payment that is electronic only, which means such currency is exchanged exclusively via digital means [186]. In this way, the money people save in their bank accounts is not digital currency as people are able to transform the electronic record of currency holdings into paper bills by ATM or banks [238]. There are two main varieties of digital currencies: cryptocurrency (traditional cryptocurrency and stablecoins) and central bank digital currency (CBDC).

Compared to cryptocurrency that is essentially a decentralized private virtual commodity or asset, CBDC is issued and overseen by a national central bank and is a legal tender currency [169]. In this sense, it has significant potential and advantages over other types of digital currencies to attract everyday users, especially those who are reluctant to use digital payments, because they will not be required to link their bank account information when using digital P2P payments. Compared to how digital P2P payments are currently operating, digital P2P payments built upon the CBDC possess may lead to faster transactions and lower transaction costs to reduce the sense of awkwardness and tension in existing interpersonal relationships.

Additionally, integrating CBDC integration with digital P2P payments may lead to higher accessibility and increased security than existing digital P2P payments. First, it would work as an alternative to cash without the need to be linked with bank account information, which will reduce people's common concerns, especially older adults' concerns, about scammers to steal money by obtaining private personal information. This would also help potential users gain more trust in using digital P2P payments. Second, CBDC is able to work without Internet connection [221]

by using near field communication (NFC) technology, which demonstrates a higher accessibility than traditional digital P2P payments that are online only. Therefore, people can make personal transactions via future digital P2P payments in both online and offline modes. Third, as CBDC is digital only (i.e., no physical form), it can significantly reduce the barriers for a larger population to access and use digital P2P payments, rather than always requiring a smart phone. For example, a wearable band or walking stick embedded with CBDC chip may allow people, especially older adults or individuals with limited mobility, still to be able to make personal money transactions even without carrying an extra smartphone. This also means that digital P2P payments based on CBDC can also be used by lower-tier market users, because such services will not necessarily have to be limited to mobile apps on a smartphone. In this sense, integrating CBDC integration with digital P2P payments would lead to more accessible payment methods as they would allow more people to make personal money transactions regardless of their location, education level, or economic status, which help them better participate in the future digital economy.

### **8.3.2 Cross-Platform: A Universal Digital P2P Payments Network**

Ingo Money CEO Drew Edwards once said, “One of the biggest points of frustration [with P2P payments] is that everybody wants to receive money in a different way.” This statement echoes our findings: although there are various P2P payment apps on the market to meet all sorts of social needs and requirements, participants did not want to be forced to download various digital P2P payment apps or switch between different P2P payment apps now and then when making personal money transaction with different people. Indeed, to send and receive money, the sender and receiver both have to agree to use the same platform before they are able to make such transactions. In this sense, the boom of various digital P2P payments services also places excessive burden on users because they may have to establish multiple accounts with different digital P2P payment options (e.g., Zelle, Venmo, PayPal, and Cash App) for their different social networks. This over-complicates people’s digital P2P payments behaviors and thus may undermine the ease of use of digital P2P payments and reduce people’s willingness to actually use such services.

With these concerns in mind, we therefore envision that future digital P2P payments should address this urgent need for a universal digital P2P payments network. Just like Bank of American users can send or receive money to Chase Bank users directly by using their respective bank apps, all digital P2P payment services would be expected to be open and compatible to each other. This

will significantly reduce digital P2P payments users' effort to only need to select the recipient. There will be no more requirement for senders and receivers to belong to the same network, which will save their time and efforts to download and learn how to use a new digital P2P payments platform. Moreover, as people are able to make money transactions across various digital P2P payments platforms, this also indicates that digital P2P payments can be extended to customer-to-business (C2B) payments without relying too much on infrastructuralized mobile payment systems. For example, two mobile payment systems – WeChat Pay and Alipay – have been infrastructuralized in China for its ubiquitous and indispensable role in people's everyday lives [44, 94, 200]. Since most Chinese use either WeChat Pay or Alipay, it is both natural and convenient to also use these two dominant digital P2P payments methods for the C2B mode, such as making online payments with stores or merchants. Although not many countries have successfully established ubiquitous infrastructuralized mobile payment systems, a universal digital P2P payments network may facilitate the potential expansion of the use of digital P2P payments between known contacts (or strangers) to C2B in the future. For example, if a convenience store only accepts customers to pay with cash, bank cards, or Apple Pay, customers can still use their own digital P2P payment apps, such as Venmo and Zelle, to buy items. For customers, they do not have to carry cash or cards or are restricted to Apple Pay; for the convenience store, there is no need to set up multiple payment method options to cater to a wide variety of customers' preferences.

However, it should also be noted that as much as how promising and bright the future of cross-platform digital P2P payment services seems to, several potential challenges and risks should be taken into consideration. Such new questions may include: Should future digital P2P payments only focus on enabling interoperability between platforms to achieve the “cross-platform” pattern? Or should they establish a centralized hub for all digital P2P payment platforms/apps? If so, how should we ensure its safety and inner-compatibility as various brands and products will be incorporated in this open loop network? Additionally, how should we manage risks across tens of millions of senders and recipients processed simultaneously through this central hub? And how can we manage various different foreign currencies if transferring money simultaneously through this central hub? In this sense, a local digital P2P payments network still may make more practical sense and could be realized in the near future. For example, according to different types of digital P2P payment services, all local banks can connect together to achieve interoperability to help users make personal money transaction with known contacts directly.



### 8.3.3 Beyond Screen: XR-Mediated P2P Payments

This far we have envisioned how the future landscape of digital P2P payments can be more accessible, secured, and universal. Yet, these envisions are still grounded in the assumption that digital P2P payments services would still be associated with a personal digital device (e.g., a smartphone, a walking stick, or a wearable band) and with offline scenarios (e.g., paying bills). As our findings have shown, digital P2P payments users highlight that future digital P2P payments services should simulate the sense of physicality of face-to-face cash transactions, which would help better convey people’s emotions embedded in face-to-face money transactions (e.g., through body movements, gestures, eye contacts, and non-verbal cues). Focusing on this strong expectation, therefore, in this section we envision how the future landscape of digital P2P payments may also evolve beyond the screen of a device and be able to simulate experiences of physicality and face-to-face money transactions, especially by taking the increasingly important metaverse and the extended reality (XR) paradigm into account.

At the high level, the metaverse refers to a collective, persistent, and shared 3D virtual shared space including the sum of virtual worlds, augmented reality, and the Internet [157], which is increasingly shaping how people interact, connect, and socialize with each other. It is a seamless convergence of our physical and digital lives, which is creating a unified virtual community where people can work, play, relax, transact and socialize [157, 242]. Gartner, a reputed technological research and consulting firm, predicts that by 2026, 1 in 4 people will spend at least one hour a day in the metaverse for work, shopping, education, social and/or entertainment [73]. In fact, there are already emerging business opportunities in the metaverse, such as virtual shops (see Fig 8.1), virtual real estate (see Fig 8.2), play-to-earn games (players can play a game and potentially earn cryptocurrency by exchanging NFTs with each other; see Fig 8.3), and virtual concerts. For instance, Travis Scott’s nine-minute Fortnite metaverse virtual concerts reportedly grossed \$20 million (see Fig 8.4) and Ariana Grande’s Fortnite concert reportedly drew 78 million viewers, making her a seven-figure payday [191]. People paying to watch virtual concerts in social VR is likely to be in fashion for the next decade. In addition, financial institutions are exploring the business opportunities to enter the metaverse. For instance, JP Morgan Chase became the first bank to open a lounge in Decentraland that could offer a space for customers to meet with advisors, attend financial education seminars, or even participate in virtual trading competitions [54]; TD Bank have launched multiple



Figure 8.1: Lancôme adopted immersive VR programs to replicate their flagship store and enable customers to browse virtually.



Figure 8.2: In Decentraland, a 3D virtual world browser-based platform, users can exchange cryptocurrencies for land and buildings.

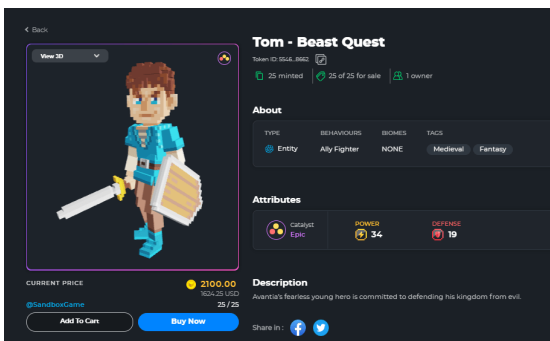


Figure 8.3: Sandbox is an Ethereum-based metaverse and gaming ecosystem. It allows users to construct and animate 3D objects such as people, animals, and tools, etc. User can distribute and monetize these in-world assets.



Figure 8.4: Travis Scott's Fortnite metaverse virtual concerts: the entire Fortnite island was the stage. During the opening song a giant Scott stomped around the island while players could run across the water to catch a glimpse.

VR features recently to provide immersive engagement for customers and colleagues [15].

Therefore, it is expected such activities will become an essential component of metaverse in the future and it is critical to also explore how people deal with money in the metaverse. In this sense, it is important to envision how XR's unique affordances to provide more immersive, natural, and intuitive interactions may offer new and exciting opportunities in digital transactions, which shows great potential for future digital P2P payments to further benefit people's social connections.

### 8.3.3.1 Integrating AR with Digital P2P Payments

We first envision that future digital P2P payments would integrate with augmented reality (AR) to promote more nuanced social interactions when making personal transactions with known contacts. This expectation has already shown in our findings as participants suggest using AR to visualize and interact with digital content in a more immersive and engaging way, which may

enhance emotion communication and add more enjoyment in the transaction process.

AR is a technology that overlays digital information, such as images, videos, or 3D models, onto the real world in real-time [20]. This is typically achieved through a digital device such as a smartphone, tablet, or smart glasses, which uses cameras and sensors to detect people's environment and superimpose digital content on top of it. In this sense, AR is different from virtual reality (VR), which is a fully immersive computer-generated virtual experience that simulates real world [37]. With AR, one is able to interact with both the physical world and the digital content overlaid on top of it [210]. Therefore, AR technology can enable digital payment apps to provide a more engaging, intuitive, and user-friendly interface by overlaying finance-related action and information on the user's environment. For example, AR could simulate the process of handing over cash or swiping a virtual credit card in a more vivid, interactive, and realistic way over people's digital screen by tapping on a 3D image that appears in their environment. This may empower people with novel context-sensitive and reinforce their awareness of the information related to situation in physical world with an intuitive interface [167]. The visualization of making cash transactions in digital devices helps both parties feel more engaged in the process [168, 236]. For example, people could hold up their phone to a product in a store or a poster/menu on the wall and see the price and payment options displayed in AR, which may contribute to further discussion of sharing cost with others.

AR can be also used to add more fun and enjoyment to digital P2P payments, making the experience of personal money transactions more engaging and rewarding and thus encouraging the adoption of the service. AR has been widely used to incorporate gamification elements to enhance adoption and engagement [43, 62, 79]. In the context of digital P2P payments, for example, people could earn rewards or bonuses for making payments through the AR-mediated built-in game. Or digital P2P payment apps could use AR to display customized recommendations for products or services based on the user's preferences and previous payment history. Moreover, AR can be used to provide enhanced security features for digital P2P payments. For example, users could use AR to scan QR codes or NFC tags to authenticate transactions and verify the identity of the recipient. In general, AR will be an effective means to keep digital P2P payments at a certain level of realism while also making use of digital P2P payments more appealing and engaging.

### 8.3.3.2 Using Digital P2P Payments in Social Virtual Reality

We also envision that integrating social virtual reality (social VR) with P2P payments could provide a unique and immersive experience for people when they deal with money in the future metaverse, while also further strengthen more nuanced social interactions in making personal transactions with known contacts.

Social VR refers to 3D virtual spaces where multiple users can interact with one another typically through VR head-mounted displays [141]. Drawing aspects from traditional online gaming and 3D virtual worlds but further extending them, social VR platforms demonstrate specific nuances to allow users to experience immersive and realistic interactions comparable to offline worlds via embodied avatars with full-body tracking (e.g., simulated touching and grabbing features), synchronous voice conversations, and more customized self-presentation using customized avatars [132]. In this sense, social VR-mediated P2P payments has the potential to both ensure remote instant money transactions even in a virtual environment and to make up for the common loss of emotion in communication when making personal money transactions through traditional digital P2P payments, which has been highlighted by many of our participants.

First, embodied avatars with full-body tracking, as a unique affordance of social VR, makes the body itself become the immediate and sole interface between the user and the avatar, which fosters a much stronger sense of presence, embodiment, and attachment [69]. Therefore, social VR can provide a highly immersive and realistic experience that allows users to interact with each other in a more lifelike and engaging way than traditional digital platforms. In particular, as users customize their avatar at a higher level of anthropomorphism, the sense of embodiment will be even more stronger [121, 127, 135], which fosters an almost-real feeling to make money transactions between known contacts as if in the offline world. Additionally, the simulated and realistic environment suggests that all features that current digital P2P payments and cash have can be fully transferred to social VR platform. On the one hand, the convenience and instantaneity can still be applied into social VR context. For example, people are able to scan QR code to pay “face-to face”, or to use NFC to pay if “phone objects” are implemented in social VR. On the other hand, more non-verbal social cues and nuanced personal emotions such as care, affection, or gratitude can be included in the transaction process and be conveyed vividly via embodied avatars in social VR. Even the sense of ritual of handing over cash can be achieved in social VR when people grab “cash objects” to make

the transaction.

Second, structured virtual activities in a shared context are common in social VR [8, 141]. Integrating payments into social VR, thus, could enhance social connections by allowing people to exchange money in real-time and in the context of shared virtual experiences. For instance, people can attend virtual events such as painting, concerts, movies, going to a bar together and use P2P payments to split the cost of any paid experiences or content in real-time and “in-person” with an embodied experience. In particular, introducing digital P2P payment into social VR can facilitate the sense of exchanging tangible support (e.g., providing literal material goods such as money) [32, 53, 111, 249] even in a virtual world. In this sense, using social VR-mediated P2P payments can not only help share social support and maintain relationships beyond time and geographical limits but also promote trust between known contacts by providing a physicalized, embodied sense of exchanging money. This aspect can be especially important for people who engage in virtual commerce, as social VR platforms can integrate virtual storefronts where people can purchase digital and physical goods. By incorporating digital P2P payments with virtual commerce in social VR, people can easily pay for their purchases as paying in cash and without leaving the VR environment. For example, people can create and sell virtual items such as avatars and world models and directly receive payments from other users through digital P2P payments in social VR.

It should also be noted that while we envision social VR-mediated P2P payments may provide a variety of benefits and novel opportunities for supporting people’s social experiences and connections in the future, we also highlight several potential concerns about security, technology adoption, and platform compatibility that may emerge in this future landscape.

On the one hand, as social VR is a relatively new and still evolving novel online social space, it may not yet implement necessary security features to protect financial activities in this virtual environment, making digital P2P payments in social VR and subject to several online threats such as hacking. Therefore, it would be important to ensure that appropriate safeguards are in place to protect users’ financial information before digital P2P payments can be widely implemented and adopted in social VR.

On the other hand, integrating P2P payments into social VR would require people willing to adopt both technologies. As social VR and the future metaverse are considered new social technologies, adopting the concept of digital P2P payments in social VR would require significant time and effort from everyday users who are unfamiliar with one or both technologies. It would also

require significant time and effort to introduce this concept to the broader communities, such as less tech-savvy, not financially stable, undereducated, older adults, and marginalized communities who often suffer harassment and other personal harms in social VR [68].

Lastly, ensuring compatibility not only between different social VR platforms but also between various payment systems, especially if each platform has its own unique technical requirements, can be challenging.

In summary, we envision that integrating social VR with digital P2P payments could provide a unique, intuitive, and exciting experience, which has potential to benefit people's interpersonal relationships and social experiences in the future metaverse paradigm while also making payments more convenient and seamless. However, it would be critical to carefully consider the potential risks and challenges associated with such an integration.

## 8.4 Limitations and Future Work

This dissertation study has several limitations. First, most participants when participating in our studies were under 40 years old (e.g., millennials and Gen Z). How they perceive, use, and experience digital P2P payments might differ from people of other age groups, especially older adults, due to their varied life styles, main social relationships/cycles, cognitive patterns, emotional needs, among others. Therefore, more future work is needed to unpack how people across various age groups may demonstrate different patterns of using and experiencing digital P2P payments in their offline social relationships with known contacts. For example, in this research, participants who were over 50 years old shared that they were more likely to adopt digital P2P payments if their off-springs had used digital P2P payments to make personal transactions. In this sense, there may exist a bi-directional pattern of personal transactions through digital P2P payments, which highlights the importance of inter-generational learning and communication and the role new financial technology may play in bridging generational divides. Second, in our studies, male participants account for 66.7% of our sample. Although it is not yet known whether gender plays a role in digital P2P payments' impacts on people's offline interpersonal relationships, this can be a valuable future research direction. Third, although we used a professional platform (Prolific) to increase the diversity of our respondents as much as possible, most respondents were from South America, Europe, and South Africa. In Study 2 and Study 3, more than half of our participants were from USA and most of them self-reported

as White. We acknowledge that different cultural backgrounds, living situations, and lifestyles may lead to different payment habits and distinct perceptions of the impacts of digital P2P payments on established interpersonal relationships. Therefore, future work is needed to include a more culturally diverse sample to better explore the role of cultural expectations in (re)shaping existing interpersonal relationships through digital P2P payments. Lastly, our research through design and PD activities mainly focus on qualitative analysis from a relatively small sample of co-designers. For our future work, additional systematic quantitative and qualitative evaluations of a large sample are needed to further verify insights from our PD activities and help us depict a broader and more generalizable image of how future digital P2P payments services can be designed to meet the needs and expectations of more diverse user groups and communities.

## Chapter 9

# Conclusions and Contributions

In conclusion, through study 1 to 4, this dissertation research has highlighted significant implications of the use of digital P2P payments for interpersonal relationships between people who know each other. On the one hand, using digital P2P payments offer convenience and ease of use, making it easier for individuals to engage in personal money transactions with friends, family, and acquaintances. This thus helps strengthen their existing interpersonal relationships by facilitating communication, reciprocity, and trust. On the other hand, the use of P2P payments may also lead to negative effects on existing interpersonal relationships. For example, it could lead to a sense of distance and disconnection between people, as physical currency and face-to-face interactions with embedded social, cultural, and emotional cues are absent in the money transaction process. Additionally, P2P payments may alter social norms around gift-giving and other forms of money transactions in human behaviors, potentially disrupting established cultural traditions and norms. Moreover, influences of digital P2P payments on interpersonal relationships with known contacts may vary depending on various individual, social, and cultural factors. As such, it is important to approach this already emotionally sensitive topic (i.e., money) with even higher sensitivity and cultural awareness, and to consider the potential risks and opportunities of digital P2P payments in the context of personal relationships.

This dissertation research thus contributes to innovating financial technologies in the perspective of HCI and HCC by better understanding new and more complicated social phenomena and dynamics emerging in today's digital economy. First, this dissertation research offers one of the first empirical evidence to unpack and explicate the multidimensional influences of digital P2P payments



on both financial experiences/processes and everyday social connections between known contacts, which is understudied in prior scholarship. In doing so, we provide new perspectives on today's technology-mediated financial life and shed light on the intertwining financial and social relationships through technology. These insights also help re-conceptualize computer-mediated interpersonal relationships in today's networked society. Second, we identify and further reflect on user-generated design recommendations and develop prototypes that highlight the importance of taking the interplay of financial and social engagement, in addition to security and privacy, into consideration when redesigning digital P2P payments platforms. Through this research through design approach, we thus rethink and envision the future landscape of digital P2P payments where such technologies can be designed, developed, and used in a more comfortable, innovative, and emotionally satisfactory way. As we are entering a post COVID-19 pandemic age, there is an increasing interest to make digital financial technologies not only secure but also more human-centered, interaction-centric, and culturally sensitive, which can be used to better support and maintain human connections through daily financial activities with or without face-to-face interaction. Therefore, in a broader sense, this dissertation research on the social values of digital P2P payments also contributes to building a more robust and inclusive digital economy in today's changing society.

# Appendices

## Appendix A Interview Questions of Study 1

1. What is your gender?
2. How old are you?
3. Where do you live now?
4. What is your occupation?
5. Have you ever used Messenger payment before?

For 5, if “Yes”:

6. Do you still use it now?

For 6, if “Yes”:

7. How long have you been using it?
8. How did you know Messenger payment?
9. Why did you start to use it?
10. What do you usually use Messenger payment for?
11. How often do you do it?
12. Why did you decide to use Messenger payment for that?
13. Who do you usually pay/receive money from via Messenger? Why did you decide to use Messenger payment to pay/receive money to/from this person?
14. How, if at all, does using Messenger payment affect your relationship/interaction with this person? Please describe a positive experience with Messenger payment.
15. How, if at all, does using Messenger payment affect your relationship/interaction with this person? Please describe a negative experience with Messenger payment.
16. In general, do you feel using Messenger payment improves the quality of your life in any way (e.g., friendship; family relationships, etc.)?
17. What features of Messenger payment do you feel easy to use?
18. What features of Messenger payment do you feel challenging to use?
19. If you can change one Messenger payment feature to better serve your needs, what would that be?

For 6, if “No”:

20. How long have you been using it before you stopped?
21. How did you know Messenger payment?

22. Why did you start to use it?
23. What did you usually use Messenger payment for?
24. How often did you do it?
25. Why did you decide to use Messenger payment for that?
26. Who did you usually pay/receive money from via Messenger? Why did decide to use Messenger payment to pay/receive money to/from this person?
27. How, if at all, did using Messenger payment affect your relationship/interaction with this person? Please describe a positive experience with Messenger payment.
28. How, if at all, did using Messenger payment affect your relationship/interaction with this person? Please describe a negative experience with Messenger payment.
29. Why did you give up using it?

For 5, if “No”:

30. How did you know Messenger payment?
31. Why aren't you willing to use it? What hinders you to use this online transaction and payment method?
32. Have you noticed where the payment button is in Messenger?
33. Do you use other online payment applications, like Venmo, Zello, PayPal?
34. What advantages/disadvantages do you think Messenger payment has over other applications above?
35. What do you think of embedding a payment function into Messenger, an instant messaging application?
36. What suggestions/improvements do you think can be done to encourage you or other people to use Messenger payment?

## Appendix B Interview Questions of Study 2

1. What is your gender?
2. How old are you?
3. How would you best describe your ethnicity?
4. Where do you live now?
5. How would you categorize your area of residence? Is it urban, suburban or rural? How long have you lived there?
6. Which P2P payment apps do you use? How long have you been using them? How often do you use them?
7. How long have you been using them?
8. How often do you use them?
9. Which P2P payment apps do you use? How long have you been using them? How often do you use them?
10. Why do you use P2P payment apps?
11. What do you often use them for (e.g., splitting bills with friends, gifting grandchildren)?
12. Who do you often use P2P payment apps to receive/send money from/to? (e.g., strangers, family, friends, etc)?
13. When you use P2P apps, how do you often initiate the transaction process?
14. How do you usually deal with financial transactions between you and another person who has a relationship with you? For example, how do you split the bill when eating out? What payment methods/strategy do you prefer to use? Why?
15. Do you send/request an exact amount of money via P2P payment apps or round? Do you pay/request people an exact amount of money in cash or round? Do you think it looks a little bit petty to pay the exact money? Why?
16. What features about the P2P app you use do you like? What features about the P2P apps you use do you dislike? Why?
17. How do you feel about using P2P payment to deal with financial transactions between you and people who have a relationship with you? Is it more acceptable to transfer money by cash or check than via digital P2P payments between people who relate to each other?
18. Do you think using P2P payment apps affects your interpersonal relationship or social interac-

tions with other people in any way? Why?

19. Do you think using P2P payment apps is a positive or negative experience for maintaining/building your social relationships/interaction? Why?

20. Do you think your cultural background affects your willingness to use P2P payments in your daily social life? Why?

21. Compared to other age groups, what different challenges or unique experiences do you think you have when using P2P payments?

22. In general, what role do you think P2P payment apps play in your social life?

23. How do you think we can improve the design of P2P payment apps to better serve your social needs at your age?

## **Appendix C Survey Questions of Study 3**

### **Study on Investigating How P2P Payments Affect Interpersonal Connections**

#### **KEY INFORMATION ABOUT THE RESEARCH STUDY**

**Voluntary Consent:** Dr. Guo Freeman and her research assistant Lingyuan Li are inviting you to volunteer for a research study. Dr. Freeman is an Assistant Professor of Human-Centered Computing at Clemson University. Lingyuan Li is a Ph.D candidate in Human-Centered Computing at Clemson University. You may choose to not take part in the study, and at any point during the study, you may choose to stop taking part. You will not be punished in any way for either decision.

**Alternative to Participation:** Participation is voluntary and the only alternative is to not participate.

**Study Purpose:** The purpose of this research is to investigate social and interactive aspects of digital peer-to-peer (P2P) payments and to improve such technology for supporting both secure transactions and nuanced social interactions. P2P payment is a type of digital transactions that allows the transfer of funds between two individuals through an online or mobile app such as Venmo, Zelle, Cash App, Google Pay, WeChat Pay, PhonePe, WhatsApp Pay, Facebook Messenger Pay.

**Activities and Procedures:** Your part in this study will be to a survey regarding your perceptions and experiences of using P2P payment apps. It will take you about 15 minutes to complete this study, so please make yourself available for 20 minutes just in case.

**Risks and Benefits:** We do not know of any risks or discomforts to you in this study. The only benefit to you is the learning experience from participating in a research study. The benefit to society is the contribution to scientific knowledge.

#### **INCENTIVES**

Participants who complete all tasks will be compensated with \$2.

#### **AUDIO/VIDEO RECORDING AND PHOTOGRAPHS**

This session will not be recorded.

#### **PROTECTION OF PRIVACY AND CONFIDENTIALITY**

No identifiable information will be collected during the study. The results could be used for future research studies or distributed to another investigator for future research studies without additional informed consent from the participants or legally authorized representative. The results

of this study may also be published in scientific journals, professional publications, or educational presentations.

#### **CONTACT INFORMATION**

If you have any questions or concerns about your rights in this research study, please contact the Clemson University Office of Research Compliance (ORC) at 864-656-0636 or [irb@clemson.edu](mailto:irb@clemson.edu). If you are outside of the Upstate South Carolina area, please use the ORC's toll-free number, 866-297-3071. The Clemson IRB will not be able to answer some study-specific questions. However, you may contact the Clemson IRB if the research staff cannot be reached or if you wish to speak with someone other than the research staff.

If you have any study-related questions or if any problems arise, please contact Lingyuan at [lingyu2@g.clemson.edu](mailto:lingyu2@g.clemson.edu).

#### **CONSENT**

By participating in the study, you indicate that you have read the information written above, been allowed to ask any questions, and you are voluntarily choosing to take part in this research. You do not give up any legal rights by taking part in this research study.



**Notice:** Peer-to-peer (P2P) payment is a type of digital transactions that allows the transfer of funds between two INDIVIDUALS through an online or mobile app such as Venmo, Zelle, Cash App, Google Pay, WeChat Pay, PhonePe, WhatsApp Pay, Facebook Messenger Pay. etc. Typically, P2P payments implies that you use the apps to send/receive money with another person, **NOT** that you use it to buy something from a merchant. For example, if you use PayPal for online shopping on Amazon, this cannot be counted as P2P payments.

### **Demographics**

1. What is your age?
2. What is your gender?
  - a. Woman
  - b. Man
  - c. Non-binary
  - d. Gender fluid
  - e. Other, specify
3. How would you best describe yourself? (if mixed race, choose all that apply)
  - a. White (e.g., German, Irish, English, Italian, Polish, French, etc)
  - b. Hispanic, Latino or Spanish origin (e.g., Mexican or Mexican American, Puerto Rican, Cuban, Salvadoran, Dominican, Colombian, etc)
  - c. Black or African American (e.g., African American, Jamaican, Haitian, Nigerian, Ethiopian, Somalian, etc)
  - d. Asian (e.g., Chinese, Filipino, Asian Indian, Vietnamese, Korean, Japanese, etc)
  - e. American Indian or Alaska Native (e.g., Navajo nation, Blackfeet tribe, Mayan, Aztec, Native Village of Barrow Inupiat Traditional Government, Nome Eskimo Community, etc)
  - f. Middle Eastern or North African (e.g., Lebanese, Iranian, Egyptian, Syrian, Moroccan, Algerian, etc)
  - g. Native Hawaiian or Other Pacific Islander (e.g., Native Hawaiian, Samoan, Chamorro, Tongan, Fijian, etc)
  - h. Some other race, ethnicity or origin, please specify
4. Please indicate the country in which you were raised.
5. Which country are you located now?

6. Community Type/How would you categorize your current area of residence?

- a. Urban
- b. Suburban
- c. Rural

7. Amount of time living in the community

- a. 5 or fewer years
- b. 6 - 20 years
- c. 21+ years

**General questions about daily use of digital P2P payments and physical money payments (i.e., through cash)**

8. Which digital P2P payment apps have you used? Check all apply

PayPal; Venmo; Zelle; Google Pay; Apple Pay; Samsung Pay; Messenger Pay; Cash App; WhatsApp Pay; Alipay; WeChat Pay; Bancolombia; Lydia; Chase QuickPay; Monzo; Verse; PhonePe; Paytm; Others, please specify

9. What is the reason you started using P2P payment apps?\*

10. Of all P2P apps, think about the one you use the most, how often do you use it?

- a. (Almost) every day
- b. More than 5 times a week
- c. Several times a week
- d. About once a week
- e. Several times a month
- f. About once a month
- g. Several times a year
- h. Once a year or less

11. How long have you been using this P2P payment app that you use the most?

- a. 2 years or fewer
- b. 3 - 6 years
- c. 7+ years

12. With whom do you usually use P2P payment apps to send/receive money? Check all apply

- a. Friends

- b. Co-workers/Colleagues
  - c. Family members
  - d. Romantic partners
  - e. Acquaintances (a person that you know but who is not close to you, e.g., neighbors)
  - f. Other, please specify
13. What do you often use P2P payments apps for? Check all apply
- a. Paying/Receiving rent/utility fee
  - b. Paying/Receiving shared cost (e.g. bar tab, meals, rideshare fare, etc)
  - c. Paying/Receiving reimbursement (e.g., concert tickets, movie tickets)
  - d. Lending/Borrowing money to/from an individual
  - e. Gifting
  - f. Other, please specify
14. How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)
- 1) Learning to use digital P2P payments would be easy for me.
  - 2) I would find it easy to get digital P2P payments to do what I want them to do.
  - 3) My interaction with digital P2P payments apps would be clear and understandable.
  - 4) I find digital P2P payments flexible to use.
  - 5) It would be easy for me to become skillful at using digital P2P payments apps.
  - 6) Overall, digital P2P payments apps are easy to use.
15. How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)
- 1) Using digital P2P payments would enable me to accomplish transactions more quickly
  - 2) Using digital P2P payments would improve my experience of money transfers with people whom I have an existing relationship with.
  - 3) Using digital P2P payments would make it easier to make money transactions with people whom I have an existing relationship with.
  - 4) I would find using digital P2P payments useful in making money transactions with people whom I have an existing relationship with.
16. What are the benefits of using a P2P app to send/receive money between you and people who have an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you?

Check all that apply

- a. It's free or low cost
  - b. It's instant payment so others can send me money at the moment
  - c. It's convenient so I do not worry about forgetting to pay the person
  - d. Everyone I know uses it
  - e. I don't want to carry cash
  - f. It's fun, social
  - g. It's easy to use
  - h. Other, please specify
17. How likely are you to use a P2P payment app to initiate a transaction for requesting money back from people who have an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you? (Options: 7 point Likert anchored from Extremely unlikely to Extremely likely)
18. Do you round or pay the exact amount when paying someone who has an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you the repayment via digital P2P payments?
- a. Always round up (for example, pay \$5 for \$4.5)
  - b. Always round down (for example, pay \$4 for \$4.5)
  - c. Pay the exact amount
  - d. It depends on what kind of relationship I have with the person
  - e. It just depends on the amount (for example, pay \$4 for \$4.25; pay \$5 for \$4.95)
19. Do you round or ask for the exact amount when requesting money from someone who has an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you via digital P2P payments?
- a. Always round up (for example, ask people to pay \$5 for \$4.96)
  - b. Always round down (for example, ask people to pay \$4 for \$4.5)
  - c. Ask for the exact amount
  - d. It depends on what kind of relationship I have with the person
  - e. It just depends on the amount (for example, ask people to pay \$4 for \$4.25; ask people to pay \$5 for \$4.95)

20. How likely are you to notify/remind people who have an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you for repayment by sending automated reminders via P2P apps? (Options: 7 point Likert anchored from Extremely unlikely to Extremely likely)

21. How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

1) I intend to continue using digital P2P payments in the future.

2) I will always try to use digital P2P payments in my daily life

3) I plan to continue using digital P2P payments frequently

22. How often do you use **physical money (i.e., cash)** to make personal financial transactions with people who have an existing relationship with you (e.g., friends, colleagues, family members, neighbors, etc)?

a. (Almost) every day

b. More than 5 times a week

c. Several times a week

d. About once a week

e. Several times a month

f. About once a month

g. Several times a year

h. Once a year or less

23. With whom do you usually use **physical money (i.e., cash)** to send/receive money?

a. Friends

b. Co-workers/Colleagues

c. Family members

d. Romantic partners

e. Acquaintances (a person that you know but who is not close to you, e.g., neighbors)

f. Other, please specify

24. What do you often use **physical money (i.e., cash)** for? Check all that apply

a. Paying/Receiving rent/utility fee

b. Paying/Receiving shared cost (e.g. bar tab, meals, rideshare fare, etc)

c. Paying/Receiving reimbursement (e.g., concert tickets, movie tickets)

d. Lending/Borrowing money to/from an individual

e. Gifting

f. Other, please specify

25. How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Learning to use physical money (i.e., cash) would be easy for me.
- 2) I would find it easy to get physical money (i.e., cash) to do what I want them to do.
- 3) My interaction with physical money (i.e., cash) would be clear and understandable.
- 4) I find physical money (i.e., cash) flexible to use.
- 5) It would be easy for me to become skillful at using physical money (i.e., cash).
- 6) Overall, physical money (i.e., cash) is easy to use.

26. How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using physical money (i.e., cash) would enable me to accomplish transactions more quickly
- 2) Using physical money (i.e., cash) would improve my experience of money transfers with people whom I have an existing relationship with.
- 3) Using physical money (i.e., cash) would make it easier to make money transactions with people whom I have an existing relationship with.
- 4) I would find using physical money (i.e., cash) useful in making money transactions with people whom I have an existing relationship with.

27. What are the benefits of using **physical money (i.e., cash)** to give/receive money between you and people who have an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you? Check all that apply

- a. It's instant payment so others can send me money at the moment
- b. It's convenient so I do not worry about forgetting to pay the person
- d. Everyone I know uses it
- e. I don't want to use digital payments
- f. It's fun, social
- g. It's easy to use
- h. Other, please specify

28. How likely are you to use physical money (i.e., cash) to initiate a transaction for requesting money back from people who have an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you? (Options: 7 point Likert anchored from Extremely unlikely to Extremely likely)

29. Do you round or pay the exact amount when **paying** someone who has an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you the repayment via **physical money (i.e., cash) payments**?

- a. Always round up (for example, pay \$5 for \$4.5)
- b. Always round down (for example, pay \$4 for \$4.5)
- c. Pay the exact amount
- d. It depends on what kind of relationship I have with the person
- e. It just depends on the amount (for example, pay \$4 for \$4.25; pay \$5 for \$4.95)

30. Do you round or ask for the exact amount when **requesting** money from someone who has an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you via **physical money (i.e., cash) payments**?

- a. Always round up (for example, ask people to pay \$5 for \$4.96)
- b. Always round down (for example, ask people to pay \$4 for \$4.5)
- c. Ask for the exact amount
- d. It depends on what kind of relationship I have with the person
- e. It just depends on the amount (for example, ask people to pay \$4 for \$4.25; ask people to pay \$5 for \$4.95)

31. How likely are you to notify/remind people who have an existing interpersonal relationship (e.g., friends, colleagues, family members, etc) with you for repayment in a personal way (e.g., personal text, direct oral request, etc)? (Options: 7 point Likert anchored from Extremely unlikely to Extremely likely)

32. How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) I intend to continue using physical money (i.e., cash) in the future.
- 2) I will always try to use physical money (i.e., cash) in my daily life
- 3) I plan to continue using physical money (i.e., cash) frequently

33. Of following payment methods, which one do you prefer to receive/send payment from/to people who have an existing relationship to you (e.g., friends, colleagues, family members, neighbors, etc)?

- a. Cash
- b. Check
- c. Credit/Debit Cards
- d. Digital P2P payments
- e. Other, please specify

**Immediate social consequences of using physical money**

34. For the following statements, consider a scenario where you use physical money (i.e., cash) to make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using physical money (i.e., cash), people and I can make instant transactions easily to avoid having to discuss finances (e.g., splitting a dinner bill, etc).
- 2) Using physical money (i.e., cash), I can get paid quickly to avoid asking for delayed or forgotten repayments (e.g., concert tickets, shared cab fare, etc) back from people.
- 3) Using physical money (i.e., cash), people can pay me immediately without excuses.
- 4) Using physical money (i.e., cash), people and I can manage transaction records clearly, easily, and quickly.
- 5) Using physical money (i.e., cash), I can communicate finance-related information (e.g., to ask for money back) with people in a less personal and more neutral way.

35. For the following statements, consider a scenario where you use physical money (i.e., cash) to make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using physical money, people can easily pay me back the accurate amount of money.
- 2) Using physical money, I can easily make sure that everyone pays their fair share, even when we engage in an event with multiple payments (e.g. movie, meal, taxi ride, etc).
- 3) Using physical money, people can pay me back immediately.
- 4) Using physical money, everyone has an equal chance to be the one who pays the group.



bill and collects contributions from the others.

36. For the following statements, consider a scenario where you use physical money (i.e., cash) to make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using physical money (i.e., cash), I can make small talk (e.g. sharing life updates, showing care, etc.) while making transactions with people.
- 2) Using physical money (i.e., cash), I feel a sense of ritual during the transactions.
- 3) Using physical money (i.e., cash), I am able to communicate my gratitude when people are offering me financial help.
- 4) Using physical money (i.e., cash), I am able to communicate my support and care when I am offering people financial help.
- 5) Using physical money (i.e., cash), I am able to communicate my unhappiness towards people who owe me money while making transactions with them.

**Attention check! What is your favorite payment method?**

This is a simple question. You need to select “Cards”.

- a. Digital P2P payments
- b. Cash
- c. Cards
- d. Other

37. For the following statements, consider a scenario where you use physical money (i.e., cash) to make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) I sometimes feel pressured when I am required by people to use physical money (i.e., cash) to make money transactions with them.
- 2) I sometimes feel pressured to always carry cash with me when I hang out with people.

**Lasting impacts on dimensions of interpersonal relationships through using physical**

## money

In this section, we hope to learn about how payment methods can affect your trust in people who have an existing relationship with you. For example, when you are always paid without delay, it may improve your trust in the people who owe you money.

38. For the following statements, consider a scenario where you make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) Then how much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using physical money helps me trust the people who owe me money.
- 2) Using physical money helps the people I owe money trust me.
- 3) Using physical money creates a sense of trust among people who manage a shared cost.

In this section, we hope to learn about how payment methods can affect the potential tensions between you and people who have an existing relationship with you. For example, when people always round down the amount they owe you, it may increase tensions between you and them.

39. For the following statements, consider a scenario where you make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) Then how much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using physical money (i.e., cash) relieves tensions between me and people who owe me money.
- 2) Using physical money (i.e., cash) relieves tensions between me and people who make shared cost transactions with me.
- 3) Using physical money (i.e., cash) relieves tensions between me and people who ask for repayment/reimbursement from me.

In this section, we hope to learn about how payment methods can affect your perceived emotional attachment to people who have an existing relationship with you. For example, when the process of money transactions with people can involve personal touch, it may help strengthen your emotional attachment to them.

40. For the following statements, consider a scenario where you make transactions with people who

have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) Then how much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using physical money (i.e., cash) increases the emotional bond between me and people.
- 2) Using physical money (i.e., cash) increases the emotion expression between me and people.

### **Immediate social consequences of using digital P2P payments**

41. For the following statements, consider a scenario where you use digital P2P payments to make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using digital P2P payments, people and I can make instant transactions easily to avoid having to discuss finances (e.g., splitting a dinner bill, etc).
- 2) Using digital P2P payments, I can get paid quickly to avoid asking for delayed or forgotten repayments (e.g., concert tickets, shared cab fare, etc) back from people.
- 3) Using digital P2P payments, people can pay me immediately without excuses.
- 4) Using digital P2P payments, people and I can manage transaction records clearly, easily, and quickly.
- 5) Using digital P2P payments, I can communicate finance-related information (e.g., to ask for money back) with people in a less personal and more neutral way.

42. For the following statements, consider a scenario where you use digital P2P payments to make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using digital P2P payments, people can easily pay me back the accurate amount of money.
- 2) Using digital P2P payments, I can easily make sure that everyone pays their fair share, even when we engage in an event with multiple payments (e.g. movie, meal, taxi ride, etc).
- 3) Using digital P2P payments, people can pay me back immediately.
- 4) Using digital P2P payments, everyone has an equal chance to be the one who pays the group bill and collects contributions from the others.

43. For the following statements, consider a scenario where you use digital P2P payments to make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using digital P2P payments, I can make small talk (e.g. sharing life updates, showing care, etc.) while making transactions with people.
- 2) Using digital P2P payments, I feel a sense of ritual during the transactions.
- 3) Using digital P2P payments, I am able to communicate my gratitude when people are offering me financial help.
- 4) Using digital P2P payments, I am able to communicate my support and care when I am offering people financial help.
- 5) Using digital P2P payments, I am able to communicate my unhappiness towards people who owe me money while making transactions with them.

44. For the following statements, consider a scenario where you use physical money (i.e., cash) to make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) How much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) I sometimes feel pressured when I am required by people to use/download digital payment apps to make money transactions with them.
- 2) I sometimes feel pressured to use a particular P2P app when I hang out with people.

### **Lasting impacts on dimensions of interpersonal relationships through using digital P2P payments**

In this section, we hope to learn about how payment methods can affect your trust in people who have an existing relationship with you. For example, when you are always paid without delay, it may improve your trust in the people who owe you money.

45. For the following statements, consider a scenario where you make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) Then how much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using digital P2P payments helps me trust the people who owe me money.

- 2) Using digital P2P payments helps the people I owe money trust me.
- 3) Using digital P2P payments creates a sense of trust among people who manage a shared cost.

In this section, we hope to learn about how payment methods can affect the potential tensions between you and people who have an existing relationship with you. For example, when people always round down the amount they owe you, it may increase tensions between you and them.

46. For the following questions, consider a scenario where you make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) Then how much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using digital P2P payments relieves tensions between me and people who owe me money.
- 2) Using digital P2P payments relieves tensions between me and people who make shared cost transactions with me.
- 3) Using digital P2P payments relieves tensions between me and people who ask for repayment/reimbursement from me.

In this section, we hope to learn about how payment methods can affect your perceived emotional attachment to people who have an existing relationship with you. For example, when the process of money transactions with people can involve personal touch, it may help strengthen your emotional attachment to them.

47. For the following statements, consider a scenario where you make transactions with people who have an existing relationship with you (e.g., friends, family, co-workers, neighbors, etc.) Then how much do you agree or disagree with the following statements? (Options: 7 point Likert anchored from Strongly disagree to Strongly agree)

- 1) Using digital P2P payments increases the emotional bond between me and people.
- 2) Using digital P2P payments increases the emotion expression between me and people.

### **Recommendations for improving the current designs of digital P2P payments apps**

48. For all P2P apps, what features related to social interactions do you think are good to have or keep? Check all that apply

- a. The function of splitting a bill
  - b. Adding a personal payment memo/note/message for transactions
  - c. Customizing avatars or profile pictures (e.g., filters)
  - d. Having transaction news feeds
  - e. Instant messaging (e.g., incorporate payment in the chat box)
  - f. Others, please describe
49. What would you like to add in the payment note/memo when using P2P apps to make transactions? Check all that apply
- a. Emoji/Bitmoji/animated stickers
  - b. Audio clip
  - c. Video clip
  - d. Text
  - e. Others, please specify
50. Are there any features you think are needed but are missing in the current digital P2P platforms?
51. How do you think current digital P2P platforms can be improved to better support your needs for social interactions? Any suggestions?\*

## Appendix D CFA

### D.1 CFA - Digital P2P Payments

The survey items for the digital P2P payments with item loading and average variance extracted (AVE) for each factor. Removed items are colored in gray. (cont.)

Factor	Label	Item	Loading
Perceived Awkwardness AVE: 0.579 $\sqrt{(AVE)}$ : 0.761	AWK1	Using digital P2P payments, people and I can make instant transactions easily to avoid having to discuss finances (e.g., splitting a dinner bill, etc).	0.635
	AWK2	Using digital P2P payments, I can get paid quickly to avoid asking for delayed or forgotten repayments (e.g., concert tickets, shared cab fare, etc) back from people.	0.731
	AWK3	Using digital P2P payments, people can pay me immediately without excuses.	0.477
	AWK4	Using digital P2P payments, people and I can manage transaction records clearly, easily, and quickly.	0.609
	AWK5	Using digital P2P payments, I can communicate finance-related information to (e.g., ask for money back) with people in a less personal and more neutral way.	0.442
Perceived Fairness	FAIR1	Using digital P2P payments, people can easily pay me back the accurate amount of money.	
	FAIR2	Using digital P2P payments, I can easily make sure that everyone pays their fair share, even when we engage in an event with multiple payments (e.g. movie, meal, taxi ride, etc).	
	FAIR3	Using digital P2P payments, people can pay me back immediately.	
	FAIR4	Using digital P2P payments, everyone has an equal chance to be the one who pays the group bill and collects contributions from the others.	
Perceived Peer Pressure (to Use a Certain Payment Method)	PRES1	I sometimes feel pressured when I am required by people to use/download digital P2P payments to make money transactions with them.	
	PRES2	I sometimes feel pressured to use a particular P2P app when I hang out with people.	
Emotion in Communication AVE: 0.647 $\sqrt{(AVE)}$ : 0.804	EMO1	Using digital P2P payments, I can make small talk (e.g. sharing life updates, showing care, etc). while making transactions with people.	0.492
	EMO2	Using digital P2P payments, I feel a sense of ritual during the transactions.	0.461
	EMO3	Using digital P2P payments, I am able to communicate my gratitude when people are offering me financial help.	0.826
	EMO4	Using digital P2P payments, I am able to communicate my support and care when I am offering people financial help.	0.833
	EMO5	Using digital P2P payments, I am able to communicate my unhappiness towards people who owe me money while making transactions with them.	0.621
Perceived Trust AVE: 0.869 $\sqrt{(AVE)}$ : 0.932	TRUST1	Using digital P2P payments helps me trust the people who owe me money.	0.877
	TRUST2	Using digital P2P payments helps the people I owe money trust me	0.894
	TRUST3	Using digital P2P payments creates a sense of trust among people who manage a shared cost.	0.836
Perceived Tension AVE: 0.893 $\sqrt{(AVE)}$ : 0.945	TENS1	Using digital P2P payments relieves tensions between me and people who owe me money.	0.930
	TENS2	Using digital P2P payments relieves tensions between me and people who make shared cost transactions with me.	0.943
	TENS3	Using digital P2P payments relieves tensions between me and people who ask for repayment/reimbursement from me.	0.807
Emotional Attachment AVE: 0.928 $\sqrt{(AVE)}$ : 0.963	ATT1	Using digital P2P payments increases the emotional bond between me and the people.	0.954
	ATT2	Using digital P2P payments increases the emotion expression between me and the people.	0.902
Perceived Ease of Use AVE: 0.763	EASE1	Learning to use digital P2P payments would be easy for me.	0.764
	EASE2	I would find it easy to get digital P2P payments to do what I want them to do	0.708

The survey items for the digital P2P payments with item loading and average variance extracted (AVE) for each factor. Removed items are colored in gray.

Factor	Label	Item	Loading
$\sqrt{AVE}$ : 0.873	EASE3	My interaction with digital P2P payments apps would be clear and understandable.	0.801
	EASE4	I find digital P2P payments flexible to use.	
	EASE5	It would be easy for me to become skillful at using digital P2P payment apps.	0.736
	EASE6	Overall, digital P2P payment apps are easy to use.	0.805
Perceived Usefulness AVE: 0.828 $\sqrt{AVE}$ : 0.910	USE1	Using digital P2P payments would enable me to accomplish transactions more quickly.	0.770
	USE2	Using digital P2P payments would improve my experience of money transfers with people I have an existing relationship with.	0.850
	USE3	Using digital P2P payments would make it easier to make money transactions with people I have an existing relationship with.	0.869
	USE4	I would find using digital P2P payments useful in making money transactions with people I have an existing relationship with.	0.823
Intend to (Future) Use AVE: 0.741 $\sqrt{AVE}$ : 0.861	INTD1	I intend to continue using digital P2P payments in the future.	0.765
	INTD2	I will always try to use digital P2P payments in my daily life.	0.616
	INTD3	I plan to continue using digital P2P payments frequently.	0.841

The factor correlation matrix for the digital P2P payments dataset

Factor	ATT	TENS	TRUST	EMO	AWK	INTD	USE
TENS	.561						
TRUST	.577	.792					
EMO	.636	.383	.505				
AWK	.148	.428	.467	.257			
INTD	.192	.222	.290	.304	.594		
USE	.180	.250	.253	.208	.526	.764	
EASE	.056	.181	.148	.079	.525	.627	.616



## D.2 CFA - Physical Money

The survey items for the physical money with item loading and average variance extracted (AVE) for each factor. Removed items are colored in gray. (cont.)

Factor	Label	Item	Loading
Perceived Awkwardness AVE: 0.546 $\sqrt{(AVE)}$ : 0.739	AWK1	Using physical money (i.e., cash), people and I can make instant transactions easily to avoid having to discuss finances (e.g., splitting a dinner bill, etc).	0.613
	AWK2	Using physical money (i.e., cash), I can get paid quickly to avoid asking for delayed or forgotten repayments (e.g., concert tickets, shared cab fare, etc) back from people.	0.599
	AWK3	Using physical money (i.e., cash), people can pay me immediately without excuses.	0.492
	AWK4	Using physical money (i.e., cash), people and I can manage transaction records clearly, easily, and quickly.	0.522
	AWK5	Using physical money (i.e., cash), I can communicate finance-related information (e.g., to ask for money back) with people in a less personal and more neutral way.	0.502
Perceived Fairness	FAIR1	Using physical money (i.e., cash), people can easily pay me back the accurate amount of money.	
	FAIR2	Using physical money (i.e., cash), I can easily make sure that everyone pays their fair share, even when we engage in an event with multiple payments ( e.g., movie, meal, taxi ride, etc).	
	FAIR3	Using physical money (i.e., cash), people can pay me back immediately.	
	FAIR4	Using physical money (i.e., cash), everyone has an equal chance to be the one who pays the group bill and collects contributions from the others.	
Perceived Peer Pressure (to Use a Certain Payment Method)	PRES1	I sometimes feel pressured when I am required by people to use physical money (i.e., cash) to make money transactions with them.	
	PRES2	I sometimes feel pressured to always carry cash with me when I hang out with people.	
Emotion in Communication AVE: 0.659 $\sqrt{(AVE)}$ : 0.812	EMO1	Using physical money (i.e., cash), I can make small talk (e.g. sharing life updates, showing care, etc). while making transactions with people.	0.539
	EMO2	Using physical money (i.e., cash), I feel a sense of ritual during the transactions.	0.572
	EMO3	Using physical money (i.e., cash), I am able to communicate my gratitude when people are offering me financial help.	0.761
	EMO4	Using physical money (i.e., cash), I am able to communicate my support and care when I am offering people financial help.	0.803
	EMO5	Using physical money (i.e., cash), I am able to communicate my unhappiness towards people who owe me money while making transactions with them.	0.618
Perceived Trust AVE: 0.830 $\sqrt{(AVE)}$ : 0.911	TRUST1	Using physical money (i.e., cash) helps me trust the people who owe me money.	0.756
	TRUST2	Using physical money (i.e., cash) helps the people I owe money trust me.	0.892
	TRUST3	Using physical money (i.e., cash) creates a sense of trust among people who manage a shared cost.	0.843
Perceived Tension AVE: 0.852 $\sqrt{(AVE)}$ : 0.923	TENS1	Using physical money (i.e., cash) relieves tensions between me and people who owe me money.	0.829
	TENS2	Using physical money (i.e., cash) relieves tensions between me and people who make shared cost transactions with me.	0.923
	TENS3	Using physical money (i.e., cash) relieves tensions between me and people who ask for repayment/reimbursement from me.	0.803
Emotional Attachment AVE: 0.908 $\sqrt{(AVE)}$ : 0.953	ATT1	Using physical money (i.e., cash) increases the emotional bond between me and the people.	0.964
	ATT2	Using physical money (i.e., cash) increases the emotional expression between me and the people.	0.851
Perceived Ease of Use AVE: 0.683 $\sqrt{(AVE)}$ : 0.827	EASE1	Learning to use physical money (i.e., cash) would be easy for me.	0.544
	EASE2	I would find it easy to get physical money (i.e., cash) to do what I want them to do.	0.744
	EASE3	My interaction with physical money (i.e., cash) would be clear and understandable.	0.758

The survey items for the digital P2P payments with item loading and average variance extracted (AVE) for each factor. Removed items are colored in gray.

Factor	Label	Item	Loading
	EASE4	I find physical money (i.e., cash) flexible to use.	0.619
	EASE5	It would be easy for me to become skillful at using physical money (i.e., cash).	0.751
	EASE6	Overall, physical money (i.e., cash) is easy to use.	0.773
Perceived Usefulness AVE: 0.824 $\sqrt{AVE}$ : 0.907	USE1	Using physical money (i.e., cash) would enable me to accomplish transactions more quickly.	0.810
	USE2	Using physical money (i.e., cash) would improve my experience of money transfer with people I have an existing relationship with.	0.893
	USE3	Using physical money (i.e., cash) would make it easier to make money transactions with people I have an existing relationship with.	0.818
	USE4	I would find using physical money (i.e., cash) useful in making money transactions with people I have an existing relationship with.	0.869
Intend to (Future) Use AVE: 0.820 $\sqrt{AVE}$ : 0.906	INTD1	I intend to continue using physical money (i.e., cash) in the future.	0.693
	INTD2	I will always try to use physical money (i.e., cash) in my daily life.	0.897
	INTD3	I plan to continue using physical money (i.e., cash) frequently.	0.869

**The factor correlation matrix for the physical money dataset**

Factor	ATT	TENS	TRUST	EMO	AWK	INTD	USE
TENS	.542						
TRUST	.590	.734					
EMO	.663	.485	.509				
AWK	.318	.598	.546	.432			
INTD	.402	.434	.451	.380	.564		
USE	.314	.481	.475	.395	.665	.377	
EASE	.128	.214	.208	.239	.250	.678	.418

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