Cash, Cards or Cryptocurrencies? A Study of Payment Culture in Four Countries

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***Abstract*—Payment cultures around the globe are diverse and have significant implications on security, privacy and trust. We study usable security aspects of payment cultures in four culturally distinct societies. Based on a qualitative study in Germany and Iran, we developed an online survey and deployed it in Germany, Iran, China, and the United States. The results reveal significant differences between the studied countries. For example, we found that participants from Iran and China are more comfortable with credential sharing and German participants were most accepting towards cryptocurrencies. We suggest these kinds of differences in payment culture need to be considered in the context of HCI research when evaluating current payment mechanisms or designing new ones.**

***Index Terms*—Usable Security and Privacy, Payment Culture, User Study, Survey**

1. Introduction

Exchanging money for goods and services is the foundation of our capitalist world. Within the last century, a plethora of different electronic payment instruments has shaped our trading culture and partially even replaced physical money. Examples of such electronic payment services are phone or SMS-based models or sophisticated software coupled with biometric authentication. The current rise of cryptocurrencies such as Bitcoin or Etherium marks the newest chapter of this evolution [1], [2].

The gradual change away from physical money in everyday trading situations poses challenges to individuals' management of financial assets. Instead of managing a single bank account and cash withdrawn from one account, users have the burden of choice to interact with different services. As electronic payment instruments often have complex and poorly understood information-sharing models and nontransparent networks of multinational service providers (e.g., German *girocard* debit cards in international contexts which are dependent on co-branding for international use, cf. Section 4), supporting users' trust is often difficult.

Trust is a multidimensional concept [3]. In traditional (non-financial) settings, perceived usefulness and ease of use are important factors for user trust [4], whereas in payment context, perceived security and privacy become increasingly important [5], [6]. Users desire security features such as secure connections, two-factor authentication, and other mechanisms to prevent fraud and "hacking", as well as privacy features such as data protection and responsible sharing of customer data [7]–[9]. Finally, concepts like cryptocurrencies also introduce new types of risks and attacks (e.g. loss of cryptographic keys and money) that may be hard to grasp could result in lower levels of trust.

Trust is shaped by cultural, societal, legal and economic factors. These factors also play a role in how people accept payment instruments [10]–[12], which is why studying trust in payment with a Western lens is hardly generalizable to other populations. Previous work has already identified culture as an influential factor in payment choices [13] and security attitudes [14], [15]. As most related studies considered cultures in isolation and focused on either security factors or payment choices, a comparative analysis of payment cultures and holistic consideration of security and cultural factors alike is needed.

We contribute a comparative user study on security, privacy, and trust across all modern payment methods from a usable security perspective. Our study places emphasis on user experiences with payment systems and their security and privacy features beyond traditional physical money with a focus on online payments, card-, mobile- and phone-based payments as well as cryptocurrencies. In particular, we sought to answer the following research questions: (1) How do people perceive security and privacy in banking and payment instruments? (2) What factors do people consider when selecting a payment instrument? (3) What demographic, societal, and socioeconomic factors influence payment culture?

Following an inductive approach, we first conducted ten semi-structured interviews in Germany and Iran. Based on these findings, we generated a set of hypotheses and designed an online survey ($n = 1961$) which was deployed in different societies with regard to banking and payment systems, i.e., Germany, Iran, China and the USA.

DOI 10.1109/EuroS&PW51379.2020.00034

This cross-cultural quantitative survey was used to collect evidence on payment habits, and perceptions and misconceptions of security mechanisms. We provide insights into the payment behaviour of four populations and show that social factors have a significant effect on the acceptance and perception of payment instruments. For example, we revealed great security risks in Iranian PIN entry practices in small shops, increased interest in cryptocurrencies among the German population which could indicate a wish to leverage privacy-preserving payments into the virtual world, and that participants from China and Iran often shared payment credentials with their romantic partners.

2. Related Work

Prior literature includes studies of payment systems adoption. Differences in countries is visible across numerous papers. For example, in the USA, decision-making factors are the amount of payment, education, and household income [16]. Whereas, for French participants, these factors are transaction size, type of good, and spending place [17]. Deciding factors for German users in particular are acceptance, convenience, speed, and security against financial loss [18]. Yet, there are similarities among cultures such as that cash usage is mostly adopted when people make low-valued transactions [19].

Besides financial factors, cultural nuances can play a key role in people's choices [13], [20], [21]. For example, in Denmark, *purchase* (context, time, amount), *personal* (control, cultural beliefs, risk), *payment instrument* (convenience, expenditure, spending), and *physical technology* (sensory perception, equipment) can affect how people interact and choose a payment instrument [22]. Ethnographic field works in the UK and India show the adoption of new payment methods is not easy and requires a decent understanding of the target population's background [23], [24]. Such behaviour is not unique to payment systems, culture is also a player in device sharing attitudes [15]. For women in countries like India, Pakistan, and Bangladesh, device sharing is common and they do not see it as a breach of their privacy [15].

Other cultural elements potentially influence choices; collective nations, e.g. China, are more accepting towards risky decisions because they feel supported by the group if anything bad happens [25]. A survey of 3500 people from seven countries shows that a global view to security research is not feasible because users' perceptions of security depend on their culture, nationality or location [14].

Several other studies focus on the understanding of trends in payment methods. A survey in the USA shows a slight increase in adoption rates of e-payments (1.2% points from 2013 to 2014) and virtual currencies (0.4%), which suggests an increasing popularity of digital payments [26]. Differences between European countries have been another interesting topic for researchers [27], [28]. For example, Germans use cash in everyday life; 82% of German direct payments in 2008 were in cash (52% in terms of amount) [27]. Also, Austrian and German users prefer cash over other payment instruments regardless of transaction value. They perceive cash as a convenient and privacy-preserving offline payment method, that is cash transactions are not recorded anywhere [18], [29]. Another study showed that banking terms and conditions are particularly hard to understand for German customers in comparison to populations from the UK and US [30].

While there is multiple research in the literature with cross-cultural viewpoints, our work focuses on nations that have not yet been compared. We look into payment culture and study four societies with a distinct cultural background. We elicit an understanding of payment habits and trust of populations which are still underrepresented in our research community and compare identified behaviour and attitudes to users from Western societies.

3. Methodology

We follow an inductive approach starting with an exploratory qualitative study.

We conducted semi-structured interviews in two different countries to open the problem field and gather first impressions on payment instrument use and concerns. The interview study was conducted as part of one author's master's thesis and thus should be considered like a pilot study. Based on these results and related work, we designed a survey and gathered quantitative data across four countries. The survey was deployed on different (country-specific) online platforms. In all cases, we did not record any personal information and we complied with national privacy regulations and the EU's General Data Protection Regulation (GDPR) for this type of research study.

We translated the interview script and the online survey to match the respective official languages of the target population. Each was drafted in English first and then translated by respective native speakers. To ensure translation quality and accuracy, additional native speakers were asked to proofread the translations and compare them to the original English version.

The chosen countries cover four geographical regions (Europe, Middle East, East Asia, North America), each with a different culture, language, economic and political system. Regardless of these differences, a similar set of payment methods is available to the citizens of these countries [31]–[34].

4. Countries of Study

In the following, we present a short overview on the four countries we studied, their economic context and eco-political features (see also Table 1). We consciously refrained from including quantified data on culture such as the Hofstede scores [35] because they reproduce the essentialist view that all individuals of a country share the same values. These nation-level models implicate that no information about the individual people of a country can be derived from them, thus luring readers into false impressions [36]–[38]. We therefore abstain from reporting such quantitative metrics for our countries of study.

The People's Republic of China (PRC) is a sovereign state in East Asia and the world's most populous country, with a population of around 1.4 billion [39] and the second biggest economy in the world [40]. Internet access to resources outside of China has been regulated which resulted in the rise of successful national counterparts of international services [41]. However, many Chinese internet users use methods like a VPN to unblock websites

TABLE 1. COUNTRY COMPARISON REGARDING POPULATION AND CURRENCY. EXCHANGE RATES ACCESSED ON 2020-06-01.

Feature	China	Germany	Iran	USA
Population	1.4 billion	83 million	81.8 million	327 million
Currency	Renminbi (Yuan)	Euro	Rial	US Dollar
Exchange rate to USD	0.14	1.11	0.000024	1
Bank notes	0.1 - 100 Yuan	5 - 500 Euro	100 - 100000 Rials	1 - 100 USD
Coins	0.01 - 1 Yuan	0.01 - 2 Euro	50 - 500 Rials	0.01 - 1 USD

that are blocked. Recently, these regulations have been extended to Bitcoin mining and trade [42].

The Federal Republic of Germany is a central European, highly developed country with 83 million citizens as of 2020 [43]. Since 2001, the Euro is Germany's official currency (cf. Table 1). Apart from the three largest bills, all bills and coins are frequently used in daily life. In contrast to other European countries, the use of debit cards within the national *girocard* ecosystem is very common and widely regarded as the default non-cash payment instrument [28]. For international use, girocards rely on co-branding with *Maestro* or *V-Pay* debit systems, but the more common practice for Germans is to acquire a separate credit card for travelling [44], [45].

The Islamic Republic of Iran is a developing middle eastern nation with 81.8 million cizitens as of 2018 [46]. After US sanctions between 2011 and 2015 [47], inflation rates in the country boomed (2009: 10.8%, 2014: 34.7% , 2016: 9%)[1]. At the same time, private transactions with other countries, buying and selling goods, internet shopping and international payment systems were blocked. Internet censorship in Iran is a disputable issue. Aryan et al. discuss in depth and show that more than 50% of Alexa's top 500 websites are blocked in Iran [48]. Social networks such as Twitter and Facebook are blocked (as of Feb 2018), although many Iranian politicians use Twitter as a communication channel. With such barriers, many people rely on VPN and proxy applications to access blocked websites. Although Rial is the official currency in Iran, it is more common to use the unofficial unit *Toman* (10 Rials) in daily life.

The United States of America are a federal republic in North America with about 327 million inhabitants (as of 2018 [49]). The country's economy is the largest in the world [40] and the US culture has had a large influence on most Western countries. Revelations by Edward Snowden have uncovered that the US government is monitoring (but not actively censoring) large parts of national and international internet traffic [50].

5. Interview Study

The interview study served as an exploratory pilot for the survey study and was conducted as one author's master's thesis. Its procedure differs at points from standard scientific practice such as transcription and coding, which originates on the underlying time and contribution constraints (only minimal external assistance was allowed).

The interview script contained questions about payment preferences, previous experiences with payment methods, and associated privacy and security concerns. The questions were based on related work and our research questions. The procedure was tested with two pilot interviews which resulted in minor adjustments. The interview script was drafted in English and then translated to Farsi and German. An independent proofreader checked the translations before the study began.

1. https://www.cbi.ir – accessed: 02/8/2018.

TABLE 2. INTERVIEW STUDY DEMOGRAPHICS AND INFORMATION WHETHER A PARTICIPANT HAS A BACKGROUND IN IT.

Participant	Gender	Age	Degree	Occupation	IT
IR1	F	26	MS	Student	No
IR2	M	23	BS	Student	No
IR3	M	25	BS	Student	Yes
IR4	F	22	BS	Course Coordinator	No
IR5	F	27	BS	Student	No
DE6	F	25	State Examination	Unemployed	No
DE7	M	23	Diploma	Student	No
DE8	F	23	Diploma	Student	No
DE9	F	19	Diploma	Student	No
DE10	M	57	MS	Freelancer	No

The semi-structured interviews were conducted in Farsi (in Iran) and German (in Germany) in a quiet room at a university. The interviewers took notes and audio-recorded the interviews. There was no full audio transcript, but the researchers enriched their notes with quotations and further material from the audio recordings. The interviews lasted about an hour per participant. All participants were compensated with €10 resp. 450,000 Rials. All participants signed an informed consent form.

We recruited 10 participants (cf. Table 2) by posting flyers at universities and libraries both in Bonn (Germany) and Teheran (Iran). We refrained from using security and privacy-related terms to prevent a sample bias.

One author applied two rounds of Grounded Theory-like line-by-line open coding to detect observable patterns. This process resulted in 260 and 223 pieces of data for Iran and Germany respectively. Afterwards, descriptive and axial coding was used to thematically merge open codes into groups which resulted in 30 sub-categories. Consequently, the sub-categories were grouped into 7 main categories which describe our participants' attitudes and habits around payment (see Table 3). These categories were discussed and confirmed by both interviewers.

5.1. How Do People Perceive Security and Privacy in Banking and Payment Instruments?

We found anecdotal evidence that risk perception with regard to different payment instruments and processes is different between countries.

According to our Iranian participants, it is a common practice among shopkeepers to ask for a customer's card and enter the amount and PIN for them. They may perform the operation in the back office or behind the counter, where the customer cannot observe what is going on with their card. However, this behaviour is not typical in banks and large chain stores. In contrary, Germans are privacy concerned as it is a common practice for German customers to enter their PIN themselves. Covering the

TABLE 3. CODING CATEGORIES AND SUB-CATEGORIES FOR INTERVIEW STUDY

Finance	Impression	Usability	Lever	Right to Know	Credentials	Physical Props
Amount	News	Ease of Use	Availability	Organisations	Physical vs. Virtual	Workstation & Internet
Change	Reputation	Accessibility	It's a Must	People	Need to do a Task	Location
Exact price	Knowledge	Time	Proxy & VPN		Patterns	
Discounts	Bad experiences		Travelling		Trust	
Fees	I'm an ordinary citizen				Point of Sale	
Keep track	Reliability					
	Powerful hackers					
	Security & Privacy					

keypad with a hand and/or plastic covers over the keypad is (as opposed to Iran) a common and socially accepted practice in Germany [51].

Regarding the *reputation* of payment instruments, Iranian and German respondents tend to trust international companies more. A German participant mentioned the role and negative association of large companies as a reason for starting to think about using cryptocurrencies. Related literature confirms the significant impact of reputation on consumers' emotions and risk perception [52].

We asked participants about their *bad experiences* with payment instruments and the impact on their behaviour. All Iranians mentioned at least one bad experience with a payment instrument. Two participants in Iran who had bad experiences with losing cash limited their cash usage as a result. In Germany, four participants mentioned bad experiences with a payment instrument.

> "My wallet was stolen twice, the same happened to my family and relatives too. I am stressed when using cash ... I do not carry large amounts in my pocket [anymore]. If I get some money, I deposit it immediately [to my bank account]" (IR3).

Proxies and VPNs are specifically important to Iranian users, all Iranian respondents reported to use proxy software or VPNs without being aware of their inner workings and distinctive features. On the other hand, selling and buying VPN and proxy servers which enable users to access restricted content is implicitly prohibited in Iran [53]. As a result, the providers of such services are commonly unknown and therefore difficult to verify. Four out of five Iranian respondents reported to use Psiphon[2]. When asked about using financial services via such services, most participants reported to do so and that they never thought about the associated risks and consequences.

5.2. What Factors do People Consider When Selecting a Payment Instrument?

We identified the *amount* of money spent per transaction as a relevant factor related to the use of specific payment mechanisms. In both countries, the findings about the payment amount are consistent with the literature [54], [55]: Two participants in Iran and one in Germany mentioned they prefer to use cash for small payments.

Two Germans additionally perceived cash as a suitable instrument for *keeping track* of their spendings. Another participant reported to use an app to track her expenses.

> "[I prefer] cash in daily use because it gives me the best overview of how much money I spend" (DE6).

In both countries, people are sometimes *forced* to use a specific payment instrument by a seller. A participant from Iran mentioned that charging campus cards required internet banking. Another participant from Iran mentioned that certain services (e.g., online shopping, app stores) require certain payment methods and thereby force their users into certain payment habits.

> "If there is no card reader, you must pay in cash like in a taxi, or when I do not have a card at the moment of payment." (IR4)

Some participants from Germany mentioned the need to use credit cards when *travelling*. International travelling and the international acceptance of payment instruments are more common concerns in Germany than in Iran, presumably due to practically open borders and the higher income among the population which facilitates travelling.

5.3. What Demographic, Societal, and Socioeconomic Factors Influence Payment Culture?

It is a common practice in small Iranian shops to return sweets or gums instead of money, if the *change* is below a certain amount. Directly connected to the Iranian practice of substituting change with goods, the perceived problem of paying the exact amount has emerged from interviews conducted in Iran.

> "One of the main advantages [of cards] is that you can pay the exact cost, you do not need to get an extra good for your change" (IR2).

The possibility of *bargaining* and getting *discounts* at stores was also exclusively mentioned by Iranian participants. In contrast, however, the consideration of *transaction fees* when choosing a payment instrument was only mentioned by German participants.

The *news* aspect encompasses impressions people get from media, ads, news, newspapers, search engines, social networks, friends and word of mouth. Two Iranian participants mentioned Telegram channels as a source of information. Telegram is a widely used messaging application in Iran [56]. Two German participants mentioned their friends and family, among them computer scientists, as their source of information.

Respondents had diverse viewpoints towards trust in their family and friends. In Iran, all participants reported that they were sharing their financial credentials with at least one person from their social circle, potentially revealing their financial information. Some expressed discomfort with this situation. In contrast, only one participant from

2. https://psiphon.ca – accessed: 2019-09-23.

Germany explicitly reported that she shared her payment credentials with others. Two participants mentioned that they share some account credentials, such as Netflix or sports channels, but no financial accounts.

> "My fiance knows all my passwords since we use multiple of them together. For instance, when my Instagram account has a problem, then I use his account. [I share my credentials] just with him and no one else."(IR4)

5.4. Summary

The interview results highlight important cultural differences for handling money and payments as well as for individual security and privacy behaviour. With regards to our research questions, we learned that Iran's inflated currency and common practices for card payment shape the people's perceptions of security. Besides, Germans are rather opposed to sharing credentials and expressed the need for keeping track of their spendings. Also, participants from both countries shared a high trust in international companies.

6. Online Survey

Based on the categories we extracted from our qualitative analysis, we constructed a questionnaire with fifty closed questions, covering payment habits and instruments, and opinions on security, privacy, usability and trust. The survey furthermore included questions on the influence of media advice, the usage of VPNs and proxies, bad experiences with payment methods and a set of questions on cryptocurrencies. We also added two attention check questions. All surveys were hosted on SurveyMonkey. On average, participants spent about 20 minutes on the survey website.

For the design of the survey, we developed four key hypotheses based on our interview findings:

1) Digital payment methods (i.e. internet banking, mobile banking, cryptocurrencies) are prevalent in all countries with Western societies being the lead.
2) Cryptocurrencies are more frequently used in Western societies (i.e. DE, US).
3) Credential sharing is more common in non-Western societies (i.e. CN, IRN).
4) Proxies and VPNs are considered safe for conducting financial trasactions over them.

As none of the interviewees from the qualitative study had reported using cryptocurrencies, we relied on previous work by Krombholz et al. [2] to study reasons for adoption and user attitudes towards these new payment methods.

6.1. Recruitment and Participants

Our survey covers four distinct countries across three continents. Hence we had to apply various recruitment techniques suited to the target population. We recruited participants in Germany and the US via Crowdflower[3].

3. https://crowdflower.com – accessed: 2018-08-02.

TABLE 4. PARTICIPANT DEMOGRAPHICS IN THE SURVEY STUDY.

Demographic	China	Iran	Germany	USA
Gender				
Male	47.7%	57.8%	67.4%	42.6%
Female	51.7%	41.1%	28.3%	57.4%
Other	0.5%	0.9%	4.3%	0%
Age distribution				
Under 18	0.24%	0.9%	0%	0%
18-24	12.3%	37.2%	12.3%	12.8%
25-35	47.9%	46.0%	27.5%	39.6%
35-44	24.3%	9.8%	17.3%	21.7%
45-54	9.3%	1.9%	22.4%	10.8%
55-64	2.4%	1.9%	17.3%	9.9%
> 65	0.6%	1.9%	2.8%	4.9%
Education				
$<$ high school	0.49%	1.0%	2.1%	1.0%
High school	16.3%	23.5%	18.4%	23.7%
Associate degree	8.4%	10.7%	13.7%	12.9%
Bachelors' degree	70.0%	49.0%	50.0%	37.6%
Masters' degree	4.3%	10.7%	12.3%	20.8%
PhD	1.0%	5.0%	2.9%	4.0%
IT background				
Yes	18.5%	31.4%	24.6%	18.8%
No	81.4%	68.6%	75.3%	81.1%

Every participant on this platform received 1 USD as compensation. For Chinese participants, we used a Chinese crowdworking service specialised in surveys called Sojump[4]. These participants received 15 RMB (approx. 2.19 USD) as compensation.

Iranian users are not able to receive international payments. Therefore we opted for the distribution of flyers in several districts of Teheran, offering a raffle of 10 gift cards (each $1,000,000$ Iranian Rials; approx. 23.75 USD) for an online shopping website roughly comparable with Amazon[5]. Flyers did not result in enough participants; therefore, we announced our study on a classified ad website[6]. Both methods resulted in 37 valid responses, three participants from these two group received gift cards. To recruit more participants, we performed a coffee house study as suggested in related work [57]. For this purpose, one of the authors spent about a week in various coffee shops in different neighbourhoods of Teheran, asking people to fill out the survey on a provided device (a tablet or a laptop), and compensated their time with a coffee or a tea. This process resulted in 65 additional valid responses.

After removing 76 (CN), 89 (DE), 15 (IRN) and 132 (US) participants who gave incomplete answers, and 536 (CN), 16 (DE), 10 (IRN) and 13 (US) participants who did not pass our attention check questions, we retained 1620, 138, 102 and 101 valid responses from China, Germany, Iran, and the US respectively[7]. See Table 4 for demographic information of our participants. Please note that it is possible for Chinese participants to be considered adults by the law at 16 if they have their own income. We thus did not treat participants under age 18 different.

For our quantitative evaluation, we used the X^2 Test for testing proportions as well as the Mann-Whitney U Test for Likert questions. The significance levels were Bonferroni-Holm corrected for multiple comparisons where applicable. Significant results are set in **bold**.

4. https://sojump.com – accessed: 2018-08-02.
5. https://digikala.com – accessed: 2019-09-23.
6. https://divar.ir – accessed: 2019-09-23.
7. The large number of Chinese participants stems from a technical limitation of the survey platform we used.

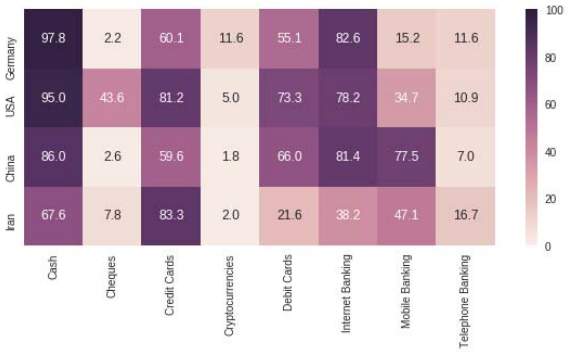

Figure 1. Payment method adoption rates across all studied countries, in percent.

6.2. Findings

Digital Payment Methods are Prevalent in All Countries with Western Societies Being the Lead. Many interview participants indicated usage of digital payment methods, i.e. internet banking, mobile banking, and cryptocurrencies. Since Western societies, in our case Germany and the US, typically have an advantage in digital infrastructure and technology, we assumed that digital payment methods are even more common there.

When looking at the adoption rates of payment methods (cf. Figure 1), we found that internet banking is more common in China than in the US, with Germany having the lead in adoption rates (Germany 82.6%, US 78.2%, China 81.4%, Iran 38.2%). While there are is no significant difference between these three countries ($X^2 = 0.128$, $p = 0.938$), the adoption rate in Iran is significantly lower ($X^2_{all} = 19.479$, $\mathbf{p < 0.01}$).

In comparison, 77.5% of Chinese participants reported to use mobile banking, compared to 15.2% in Germany, 34.6% in the US, and 47% in Iran ($X^2_{all} = 46.98$, $\mathbf{p < 0.01}$; $X^2_{IRN,US} = 1.88$, $p = 0.17$; $X^2_{US,DE} = 7.57$, $p = 0.06$; $X^2_{IRN,CN} = 7.45$, $p = 0.06$). Mobile banking is very popular in China for almost all aspects of daily life except paying rent, with 46.7% of mobile payment users reporting to pay for food using their smartphone (DE: 19%, US: 17.1%, IRN: 6.2%), and 56.4% reporting to pay this way for in-store purchases (DE: 33.3%, US: 31.4%, IRN: 6.2%).

Regarding cryptocurrencies, the results indicate that German participants were its biggest users: In general, 11.6% of German participants referred to themselves as cryptocurrency users (as opposed to 4.1% in the US, 1.8% in China, and 1.1% in Iran). Statistically speaking, the adoption rate in Germany is indeed significantly higher than in the other countries ($X^2_{all} = 12.417$, $\mathbf{p < 0.01}$; $X^2_{CN,IRN,US} = 2.178$, $p = 0.34$).

In summary, the results were mixed: Online banking is only significantly less used in Iran, mobile payments are significantly more popular in China, and cryptocurrencies have a significantly higher adoption rate only in Germany. Thus, we reject the hypothesis that Western countries are generally leading in the adoption of digital payment.

Cryptocurrencies are more frequently used in Western Societies. We hypothesized that cryptocurrencies are a more frequently used tool in Western societies (i.e. Germany and the US), since international payments, which are often needed to exchange cryptocurrencies, are harder to perform in Iran and China whose governments restrict citizens' internet access.

The overall adoption of cryptocurrencies was presented in the former subsection, with Germany having significantly more users than the other countires. Because cryptocurrency adoption in the US is not significantly higher than in China and Iran, we reject the hypothesis.

When asked about detailed experiences with cryptocurrencies, 13% of German participants reported having used them before and 7.2% reported to use them regularly. In comparison, only 7.9% of US participants reported having used them and 3.1% use them regularly. 5.8% of Chinese participants reported to have used cryptocurrencies (2.7% use them regularly), and only 4.9% of Iranian participants have used them before (1.1% use regularly).

We also tested whether having a background in computer science correlates with the adoption of cryptocurrencies and found a significant correlation within our sample of participants from China ($X^2 = 8.669$, $\mathbf{p < 0.004}$) and no significant correlation for the other countries. This might be a result of the larger sample size in China.

When asking "If X would endorse cryptocurrencies, I would use them (more often)", German participants reported that endorsement by online resources would have the biggest influence on their acceptance and usage of cryptocurrencies (28.3% agreement, highest value besides "None of the above would change my behaviour"), and radio and TV were reported as least influential to them (2.9% agreement). US-Americans reported to be moderately influenced by family and friends (29.7% agreement each), the government and newspapers were reported least influential (5.9% resp. 2.1% agreement). Chinese and Iranian participants reported their families as most influential factor (China: 46.6%, Iran: 46.1%), followed by the government (IRN: 35.3%, CN: 31.7%), and tech companies (CN: 29.6%, IRN 29.4%). Iranian participants expressed interest in the adoption of cryptocurrencies if they would be pushed more by the general public.

Credential Sharing is More Common in Non-Western Societies. We asked participants to check in a multiple-choice matrix "I'm comfortable with the following people knowing about my..." to find out which parties they trust to see their bank card details, bank transactions, online shopping details, emails, social network activities, and cellphone activities. In all categories but email, the Chinese participants had the highest rates of comfort with their spouses/significant others knowing all these information, ranging from 47.9% agreement concerning cellphone activities to 66.5% agreement about online shopping details.

When asked if they ever shared a bank credential, 38.1% of Chinese participants and 30.4% of Iranian stated they mutually share credentials with a person they trust (US: 25.7%, DE: 19.6%). We found no significant difference between the populations ($X^2 = 6.43$, $p = 0.09$), and reject the hypothesis. In contrast, 71.74% of German participants stated that they have never shared a credential (US: 48.5%, IRN: 48%, CN: 42.7%). Statistical testing yields a significant difference when comparing all coun-

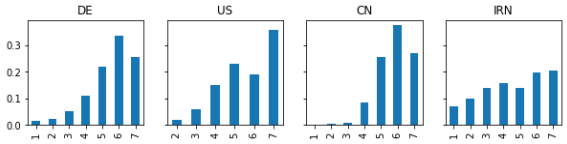

Figure 2. Relative answer distribution for the question "I am very cautious of my surroundings while conducting payment transactions.", with 1 representing "not at all" and 7 representing "very much".

tries ($X^2 = 9.5$, $\mathbf{p = 0.02}$), but no difference between China, Iran, and the US ($X^2 = 0.45$, $p = 0.8$).

We further investigated security and privacy awareness of participants by asking them to rate "I am very cautious of my surroundings while conducting payment transactions." Only Iran shows a significant difference (fewer precautions) with other countries ($MWU_{IRN,US} = 6638$, $\mathbf{p = 0.0002}$; $MWU_{IRN,DE} = 8884.5$, $\mathbf{p = 0.0003}$; $MWU_{IRN,CN} = 111250$, $\mathbf{p < 0.0001}$) which is in line with our interview findings (cf. Figure 2).

We also asked our participants two questions about third parties observing their financial transactions. Two-thirds of Iranian participants think that their government can see their financial transactions, though only 13.7% think that it is okay. Among Chinese participants, 37.5% of participants think that the government can see their transactions (compared to US: 53.5%, DE: 33.3%). However, only 11.9% of US participants think that this should be the case, as opposed to 26.5% of Chinese participants (DE: 9.4%). Across all observed countries, we saw a consensus in disagreement to the statement that advertising companies should be allowed to observe financial transactions (US: 4.9%, DE: 2.9%, CN: 1.4%, IRN: 0%).

Proxies and VPNs are considered safe for conducting financial transactions over them. In a number of countries, access to the internet is restricted by repressive governments. In those cases, software like VPNs or proxies help users overcome those restrictions. Therefore, we need to take VPN and proxy usage into account when looking at the payment context in such countries like Iran and China [58], since their usage does come with additional risks like unsolicited data collection and analysis.

Between one quarter and two thirds of participants stated that they use VPNs at least once a month (IRN 63.7%, CN 47.8%, DE 29%, US 25.7%). The differences between all countries are statistically significant ($X^2 = 22.56$, $\mathbf{p < 0.01}$). When comparing pairwise, the usage rates in China and Iran ($X^2 = 2.28$, $p = 0.13$) resp. Germany and the US ($X^2 = 0.19$, $p = 0.66$) are not significantly different. Proxies are overall less popular, between 18.8% (US) and 45.1% (Iran) of our participants use them at least once a month (China 35.1%, DE 27.5%). Again, the rates differ significantly between countries ($X^2 = 11.83$, $\mathbf{p < 0.01}$).

Germans and Iranians seem to be aware of security risks [59] when conducting financial transactions over VPNs or proxies, 64.7% of Iranians and 44.2% of Germans reported they do *not* conduct financial transactions over VPNs or proxies (CN 28.9%, US 25.7%; $X^2 = 0.23$, $p = 0.97$). Note that participants also had the option to answer "I don't use Proxy/VPN" besides the yes and no options. Across all countries, VPNs and proxies were considered not safe in general, with proxies being perceived as more unsafe throughout the field (VPN is safe: CN 29.1%, DE 24.6%, US 23.8%, IRN 21.6%; $X^2 = 1.2$, $p = 0.75$; Proxy is safe: DE 17.4%, CN 12.3%, US 11.9%, IRN 11.8%; $X^2 = 1.64$, $p = 0.65$). This finding leads us to reject the hypothesis, because our users were apparently aware about the associated risks. For all countries, a majority of users does not know their VPN or proxy providers (US: 75.6%, IRN: 72.6%, DE: 69.8%, CN: 65.1%).

Based on the results, we reject the hypothesis, because people regard proxies and VPNs as not safe. however only a small portion of Chinese and US American participants reports to not use them for financial transactions.

7. Discussion and Implications

Of our four hypotheses, none could be fully accepted. We found that among our studied countries, Chinese payment culture is leading in the adoption of mobile payment which led us to reject our first hypothesis. Cryptocurrencies are significantly more adopted in Germany, rejecting a similar assumption about the US population. The popularity of credential sharing could furthermore not be divided along the Western/non-Western axis with high sharing behaviour in the US that we observed. Regarding security and privacy perception of VPNs and proxies, they were not considered safe across the board, which rejects our fourth hypothesis that users are unaware of risks when paying over VPNs or Proxies.

Therefore, we chose not to structure the following discussion along the hypotheses, but instead along our study's general topics.

7.1. Perceptions of Security and Privacy

Our study reveals differences regarding perceived threats to private data and credential sharing. While German interviewees reported discomfort when their PIN entries were observed in public, Iranian interviewees reported the common practice of passing their cards and PINs along to shop assistants. This finding indicates that commonly assumed threat models (e.g. shoulder surfing) might not universally apply in all cultures. Since they are the basis of any secure system's design, this aspect has to be carefully considered when designing tools for international audiences.

Except for Iranians, our participants claimed that they are very cautious of their surroundings while making transactions. This outcome contradicts conclusions from previous work [51], [60] which found that most people from the UK, Sweden, Netherlands, and Germany do not take sufficient security measures while entering their PINs at ATMs. However, in contrast to related observational studies [51], [60], our findings are based on self-reported data and might thus not apply fully to practice.

At the same time, we found that card-based payments are common in Iran. In this regard, our results indicate that Iranian and Chinese participants were more comfortable than German and US participants sharing their credentials with close acquaintances like family members and spouses. This phenomenon should be of high interest to

the HCI and Usable Security communities when researching with or designing for populations in these regions.

As discussed, internet censorship is a concern in China and Iran [41], [58]. Our data indicates that people in these countries actively circumvent such barriers using e.g., VPN services and proxies without knowing their operators. In comparison, the popularity of these tools was less prevalent in the US and Germany. Even though the awareness of associated security risks was high among German and Iranian users, the use of cryptographic technologies was higher in Iran as more than half of Iranian survey respondents reported to conduct financial transactions over VPN services or proxies. This shows the use of payment instruments and the protection of privacy may require advanced technical knowledge, especially when using international services in restricted areas.

7.2. Adoption of a Payment Instrument

The findings from both our studies confirm that cash is popular in Germany compared to Iran, China and the US, with the main reason being keeping track of spendings. Even though German participants reported negative experiences with cash, the perceived benefits still seem to outweigh the negatives. We thus consider Germany a somewhat conservative society regarding payment instruments which should be considered, e.g. when it comes to the introduction of innovative cashless payment technology. A careful pace of digital payment transformation along with comprehensive and accessible educative materials about new technologies might be helpful in societies like this. The transparency and education can help in overcoming privacy concerns about new payment systems and apps.

One of the negative aspects of using cash in Germany was the risk of receiving an incorrect amount of change. While this indicates a human error or bad intentions, people in Iran reported avoiding cash payments due to technical problems. As getting the right amount of change is often not possible, change is commonly substituted by (undesired) sweets. This aspect – in contrast to our findings from Germany – might increase the acceptance for cashless payments. Another explanation for this behaviour could be the effects of a bad experience. Iranian and Chinese people had more bad experiences with cash compared to other payment instruments. To hypothesize, the popularity of mobile payment services in China might have been sprouted from bad experiences and a general aversion with cash. If this could be carefully applied this to Iran, maybe the society would be very welcoming to mobile payment solutions.

Focusing on cashless payments, mobile concepts were particularly popular in China compared to other countries. This could result from popular apps which are specifically tailored towards the Chinese culture and lifestyle [61] and big companies like Alibaba pushing users toward their cashless payment systems [62]. Our results indicate that tailoring payment instruments to accommodate local payment culture among their user groups could help in raising adoption rates and, more importantly, providing a secure environment for payment transactions.

The data from our survey suggests that German participants are far more accepting towards cryptocurrencies in comparison to participants from other countries. One of the reasons that Germans like cash is its privacy benefit [18], [29]. Therefore, a possible reason for higher cryptocurrency adoption in Germany could be rooted in the idea of cryptocurrencies and their privacy-preserving nature. Also, the use of this relatively new payment instrument seems to be more common in wealthy Western nations which could result from available infrastructure and more options to spend such currencies.

We also found that news and media articles have a considerable impact on how secure and reliable a payment instrument is perceived. Media seems to influence the adoption of payment instruments indirectly. For example, US participants reported that online resources have a high impact on their usage behaviour and acceptance. Likewise, many Iranian participants reported that the low proliferation dissuades them from using cryptocurrencies, even though they expressed high interest in this payment instrument. Researching this influence further and how it impacts system use and design would be an interesting opportunity for future work.

7.3. Payment Culture

We identified cultural norms regarding payment which are specific to the respective societies. The use of candy or gums to substitute small amounts of change in Iran clearly represents such a habit. This directly affects the use of payment instruments as many Iranian consumers rely on other payment methods than cash, such as cards, as they disagree with the substitution and prefer exact payments, thus avoiding change. Such habits and their influences on payment culture have – to our best knowledge – not been systematically researched yet. This would be an interesting endeavour for future work.

The habits reported by German study participants confirmed that German consumers are concerned about privacy and like to be in control of their own credentials. In contrast, credential sharing with close family members was commonly accepted among our Iranian and Chinese participants. This once again illustrates the importance of considering cultural differences in usable privacy and security research as well as systems design.

8. Limitations

Recruiting comparable samples in the four countries was a major challenge as the countries are diverse in terms of educational background, cultural and political factors. In order to get a truly global view, larger and more representative samples per country and a comparison of more countries per geographic region is needed.

Internet access is not equally available to citizens in the surveyed countries which also biases our sample towards the population with access to modern communication technology. Due to the recruiting method in our quantitative study, our sample of participants is potentially biased and not representative of the entire population from the studied countries. In our qualitative study, interview participants were mostly students, and we distributed our interview flyers in two universities which introduces bias toward younger and more educated participants. Such

participants tend to make active use of several payment instruments and thus might have skewed the results towards the population of early-adopters.

Moreover, translations to other languages may not convey the same meanings and participants may have had different understandings from our text. For example, Iranians are shown as users of debit and credit cards. However, credit cards in Iran are not common, and there is a high probability that some participants could not distinguish the difference between credit and debit cards. We initially planned to recruit participants online. Due to the challenges we faced in Iran, we changed our recruitment strategy and used the coffee shop method.

9. Conclusions and Future Work

In this paper, we explored payment cultures and user perceptions of payment instruments with respect to security, privacy, and trust across four countries: China, Germany, Iran, and the USA. We found that unique societal features such as Iranian shopkeepers entering customers' card PINs, clearly shaped security and privacy perceptions. Also, Chinese and Iranian participants expressed comfort regarding credential sharing with close acquaintances in contrast to participants from Germany. We also found that proxy software and VPN services are popular in Iran and China, presumably due to mistrust in the government and censorship. While participants generally regarded these tools as unsafe, many of them nonetheless conduct payments over them. In addition, German participants were most willing to accept cryptocurrencies.

Our results suggest that the preference for a particular payment instrument is influenced by local payment culture as well as media. Therefore, we argue that tools to perform sensitive financial transactions should respect these cultural factors and consider them already in the design phase for large-scale adoption.

This work forms a basis for further cross-nation studies on usable security aspects of payment systems. We consider the following paths for future research: (i) to study the impact of bad experiences and possible solutions to encourage future interactions, (ii) to measure the influence of proxy tools on privacy and security with respect to financial transactions, (iii) to research how credential sharing behaviour is reflected in current payment instruments and their underlying threat models, (iv) if external factors influence choices for payment instruments (e.g., social norms), and last but not the least, (v) a study on the impact of media on adoption rates of payment instruments with an emphasis on cryptocurrencies.

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