

IMPLICATIONS AND FEASIBILITY OF ALL CASHLESS

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Electronic financial transactions have become an increasingly common part of daily life for the past two decades, whether it be peer-to-peer transfers, purchasing goods online, or the other numerous payment options available. According a report by Andrew Lipsman from eMarketer, e-commerce was responsible for 14.1% of total global retail sales in 2019, and that share is projected to rise to 22% by 2023 (Lipsman, 2019). Governments and banks in many countries are even working to implement Central Bank Digital Currency (CBDC), which is essentially a type of legal tender in digital form that could be used for payment and value storage (Lee et al., 2021). Due to the rise in popularity of digital payment services along with credit and debit cards, people are significantly less likely to have cash on them according to a survey conducted by US Bank, and even when they do, they tend to carry less than \$50 ("Digital Payment Platforms Primed to Topple Cash", 2017). Even though utilizing digital currency and e-commerce have several advantages, moving toward a fully cashless society poses several risks and potential privacy issues that must be addressed.

One segment of the population that has been left behind by this wave of digital transactions is the homeless population, specifically those that panhandle on the streets for money. The Council of Economic Advisors reported in 2019 that “over half a million people go homeless on a single night in the United States” ("The State of Homelessness in America", 2019). Panhandlers largely rely on people carrying cash to receive donations, so not only are they receiving less donations due to people not carrying cash as often, but they also lack the proper resources to participate in e-commerce.

The technical capstone project addresses a group of people hindered by the move to a cashless world, by providing a seamless platform that allows people to give digital donations to

the less fortunate. The platform is a web application that aims to increase the income of those seeking donations, while also helping connect them with resources they might need. Developing and testing this application offered insight on the rise and influence of digital payments because the team had to consider whether panhandlers and the less fortunate satisfied the pre-requisites for using digital payments, and adjusted the solution accordingly.

The tightly coupled STS research question seeks to provide insight into the ramifications of moving toward a cashless society. Throughout this paper, I analyzed the positives, negatives, practicality, and other effects that may result from going entirely cashless. This includes determining the requirements that must be in place in order to support a digital economy. I ultimately determined that digital currency is the logical next step given its benefits, but there are many considerations and problems that must be addressed before fully transitioning away from physical money. This paper offers a new perspective on the rise and influence of digital transactions, and potentially provides a solution for some of the problems raised by the STS research.

Literature Review

For the past several decades, cashless transactions have become increasingly prevalent. From the invention of the modern payment card way back in 1950, to the more recent introduction of digital payment services like Zelle, Venmo, and PayPal, the world has seen an incredible increase in e-commerce. As shown in Figure 1 at the top of the next page, the percent of total global retail sales that e-commerce is responsible for has been gradually increasing each year for the past five years, and is projected to continue growing at a similar rate for at least the next two years. This trend demonstrates that e-commerce is becoming a significant influence on the global economy, and will likely account for an even greater share of sales in the near future.

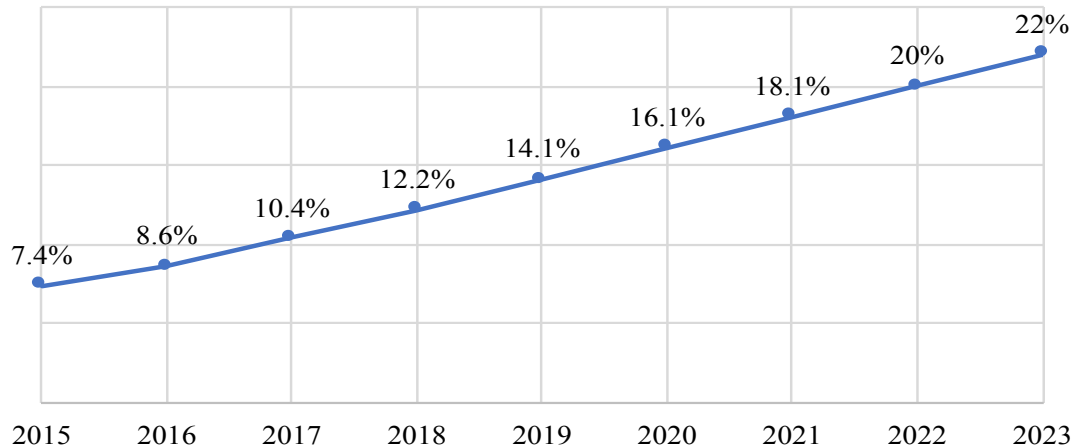


Figure 1: E-commerce Share of Total Global Retail Sales from 2015 to 2023. Each year, e-commerce grows by two percent in its share of total retail sales (Adapted by Rhoads, J., from data provided by Winkler, 2020).

According to Shopify’s business encyclopedia, e-commerce is defined as “the buying and selling of goods or services using the internet, and the transfer of money and data to execute these transactions” (Shopify, n.d.). This is a relatively broad definition, since it essentially encompasses any transfer of money that is not cash or check. There are several different forms of e-commerce, and they cover all relationships between businesses and consumers. Figure 1 at the top of this page mainly demonstrates the influence of business to consumer models of e-commerce, but consumer to consumer models are also being adopted quickly. A survey conducted by McKinsey & Company in 2019 revealed that “77% of people used one or more types of mobile payments” during the last year (McKinsey & Company, 2019). The same report also broke down mobile payment users by generation, with 91% of millennials, 80% of generation X, and 64% of baby boomers claiming to have made a mobile transaction in the last year (McKinsey & Company, 2019). People of all ages are adopting the use of digital transactions, but since the younger generations are the driving force this means e-commerce will only continue to grow.

Obviously, e-commerce and digital banking have an extensive list of advantages when compared to using cash, including “reduced costs in accessing and using banking services” along with the convenience of performing bank transactions from anywhere using the internet (Chavan, 2013). The availability of digital payment options effects our spending habits as consumers as well, with a study conducted by Liming Hou at Xiamen University concluding that “digital payments stimulate households’ total consumption, especially on long-term consumption” (Hou et al., 2021), even though digital payments do not increase a household’s total income at all. This could be viewed as positive or negative, depending on whether you’re a business or a consumer.

There are limitations and downsides to e-commerce though, such as requiring significant infrastructure, along with security issues that must be considered as society slowly transitions to cashless. An example of this is revealed in a review of the migration plan to the internet carried out by the Society for Worldwide Interbank Financial Telecommunications stating that “full migration [of e-commerce] has not occurred in many developing countries due to the lack of adequate infrastructure, working capital, and required technical expertise” (Chavan, 2013). This demonstrates that developing societies are unable to participate in e-commerce at all, limiting them further from the many benefits that it provides. Even in developed countries with prevalent digital payment options, there are impoverished people left out of e-commerce who are still affected by it because people are carrying less cash on them. According to a survey conducted by US Bank in 2017, “50 percent of respondents reported carrying cash less than half of the time” (“Digital Payment Platforms Primed to Topple Cash”, 2017). Another finding from the same survey was that when people do carry cash, 76% carry less than \$50.

Income and age also play a major factor in determining whether people carry cash or utilize cashless options. The Pew Research Center surveyed over 13,000 adults in 2018 and

found that “adults with an annual household income of over \$75,000 were more than twice as likely as those making less than \$30,000 to say they do not make any purchases using cash in a typical week” (Dickler, 2019). People who are more capable of making donations to the less fortunate are using cash at a decreasing rate, which leads to less cash being donated. Given this disparity of income between people who claim to use cash often, and the fact that developing nations as a whole struggle to implement e-commerce, it seems clear that e-commerce and digital payments contribute to wealth inequality to an extent. As for security, the rise in online transactions has “occurred with an equal rise in security strikes against electronic payments” (Hassan et al., 2020). All online transactions handle sensitive information regarding the parties involved in the transaction, so the system processing those payments must have enough measures in place to safeguard that data.

A relatively new type of technology known as Central Bank Digital Currency (CBDC) has been on the forefront of many countries’ research and development in terms of financial technology. The International Monetary Fund broadly defines CBDC as “a kind of legal tender in digital form” (Kiff et al., 2020), which encompasses a lot of forms of currency. A narrower definition of CBDC is more useful for this paper, such as one provided by David Lee in his case study on China testing CBDC: “a new type of electronic liabilities of the central bank, which can be used as a means of payment and value storage” (Lee et al., 2021). This may seem relatively similar to current forms of digital currency like Bitcoin, but the major difference is that CBDC is backed and issued by a central bank entity. This sort of technology has been in development in many different countries around the world, with “at least 36 central banks around the world having announced CBDC plans” (Lee et al., 2021). The way in which these banks implement this new currency varies, with one of the crucial design aspects being the ledger design. The ledger

can be split between token-based design and account-based depending on the needs of the system. Token-based involves the use of digital tokens being exchanged between digital wallets, while account-based refers to trading CBDC through an account with the central bank or commercial banks. There are usually two different types of CBDC: wholesale and retail. These differ mainly in the purpose they would be used for, with wholesale primarily being used by financial institutions to transact financial assets, and retail being used for payments, remittances, and receiving government incentives subsidies (Lee et al., 2021).

Regardless of the type of CBDC, both centralized or decentralized governance can be applied, or even a combination of the two. In terms of operation mode, one-tier or multi-tier designs could be implemented. The one-tier model has the central bank issuing CBDC directly to the public, while multi-tier systems involve the central bank issuing the currency first to commercial banks, and then to the public.

Studies on New Currency Technologies

In order to determine the potential consequences and feasibility of transitioning to a cashless society, I researched a case study by David Kuo Chuen Lee, Li Yan, and Yu Want that analyzed the People's Bank of China and their design and testing of Central Bank Digital Currency (CBDC). David Lee, the lead author, is a professor at the Singapore University of Social Sciences and has published or contributed to several other scholarly articles regarding digital currency and financial technology. This study provides insight into the various technical structures that such a system could take on, potential positive and negative effects of using CBDC, as well as adoption enablers that would ease the transition from physical to digital currency. The authors of the study also provide a recommendation as to how a successful CBDC system should be structured at a high level. Investigating this case study helped determine

whether a cashless society can actually exist in the future, and whether or not we should continue moving toward it. In addition to this study, I also researched the effects that digital payments can have on households' consumption, which provides a more focused look into the individualized effects that a cashless society may have. Additionally, here were two studies I examined that both involved data from the China Household Finance Survey (CHFS) in 2017 that explored two different theories behind "why digital payments lead to a higher consumption without adding to households' future income" (Hou et al., 2021). One utilizes mental accounting theory to explain the increase in consumption, while the other explains that digital finance relieves liquidity limitations and also has a stronger stimulating effect for low- and middle-income families.

As for the technical project, my Capstone team researched the challenge space that our project would likely live in, and generated a set of requirements that our solution must satisfy in order to be effective. The challenge space not only includes the effects of shifting toward a cashless society, but also homelessness and panhandlers since those are the people we seek to help. In researching the challenge space, I focused on examining surveys and data related to the homeless as well as the spending habits of panhandlers. I also investigated how the prevalence of digital payment options are part of the reason that people carry less cash on them by examining data from various surveys and reading research articles on the topic.

The team as a whole conducted two expert interviews, the first of which was with computer science professor and technical advisor Yuan Tian regarding technical aspects of our initial prototype for our application. The second expert interview was with Rob White, who is the day shelter coordinator at The Haven: a low-barrier day shelter and social resource center based in Charlottesville, Virginia. We conducted the interview with Rob White to gain a better understanding of the population that would benefit from our application. After generating our list

of requirements, we then researched further to specify metrics that could be measured to determine whether that requirement was satisfied in our solution. Specifically, I researched how to measure authentication and confidentiality, including specifications for acceptable industry standards. Finally, we generated solution concepts that satisfied our critical requirements, and then selected the most promising solution based on our evaluations of each concept along with the scope and timeframe for the project.

Implementing Actor-Network Theory to Go Cashless

Transitioning to a fully digital economy is more feasible because of the introduction of CBDC due to its flexibility and many advantages it provides, but there are still problems regarding lack of infrastructure, distribution, and public trust that must be considered before discontinuing cash. For an all cashless society to exist successfully, I propose an Actor-Network Theory (ANT) model (Law & Callon, 1988), as seen in Figure 2 below, to demonstrate how digital payments and CBDC would interact with society. By placing the commercial banks in the center of the network, they form the most relationships with the other actants. This is because in

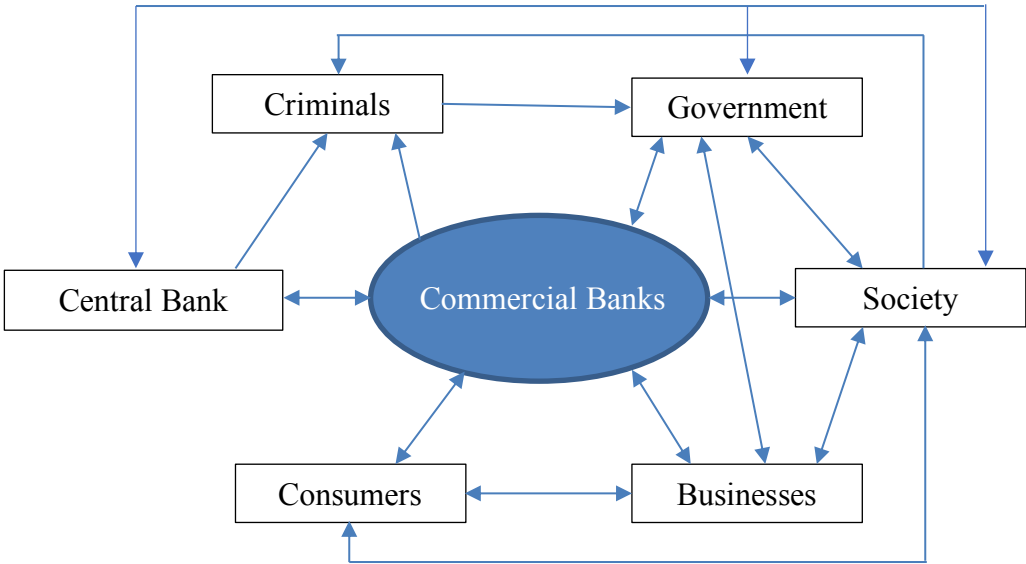


Figure 2: Cashless Society ANT Model. Commercial Banks are responsible for having high availability, as well as security against threats, due to the many relationships it has (Rhoads, 2020).

this model, the CBDC system is implemented using a three-layer design framework since it is considered to be the best practice of CBDC design because of its scalability and distribution of power from the central bank to commercial banks (Lee et al., 2021).

This system has three-layers. The first layer is the central bank issuing CBDC, the middle layer being the commercial banks that handle distributing to the third layer, consisting of consumers and businesses. The reason commercial banks are in the center instead of the central bank is because in a three-layer system, the central bank is the only entity allowed to create CBDC and issue it to commercial banks (Lee et al., 2021). The reason commercial banks form the most relationships is because they would be distributing the currency into society.

Government is another major actor in this model because “development of digital infrastructure, digital currency supervision, digital asset market supervision, and other related financial structures, are all areas that government can take into consideration” (Lee et al., 2021). In addition, CBDC allows governments to catch criminals better by providing managed anonymity instead of complete anonymity, which makes it “easier to detect illegal activities such as tax evasion, terrorist financing, and money laundering” (Lee et al., 2021). Criminals pose a threat because they may steal other users’ private data, which would lead to asset loss. This represents one of the risks of moving toward a cashless society, along with the issue of digital literacy rates being low in several regions (Lee et al., 2021).

Government and the central bank have the power to mitigate these risks by building a secure system that protects people’s data from criminals and by educating the public about the system. In doing this, society has a heavy influence on both government and the central bank in turn, since a society’s values and needs will greatly affect the design decisions for the CBDC system. Given that there are several different ways to implement CBDC, whether it be deciding

between centralized or decentralized governance, or having the system be one-tier versus multi-tier, this variety of options is crucial since societies can differ heavily depending on their needs. One of the most crucial aspects in adopting a cashless society will be the government and central bank's ability to earn society's trust because that will determine whether people switch away from cash (Lee et al., 2021). Consumers and Businesses both interact with commercial banks in a similar way in which they do now, except instead of physical cash or money in their checking accounts, they would be receiving CBDC tokens. CBDC has many advantages, including "promoting financial integration, improving transaction's efficiency and security, and decreasing the cost of cross-border payments" (MAS & Bank of Canada, 2019). It is clear there are a wealth of advantages to utilizing CBDC as a substitute for physical currency, but it is imperative that the necessary actants work to mitigate the risks and problems that are presented.

The technical project offered a more focused perspective on the effects of shifting toward a cashless society. Specifically, people are carrying cash at a decreasing rate which means they are less likely, or even unable, to donate money to less fortunate individuals such as the homeless and panhandlers. With the assistance of Computer Science professor Yuan Tian, Computer Science students Harish Chandrasekaran, Rohit Chhatre, and the author of this paper Jeffrey Rhoads are creating an application that helps to bridge the technological gap between panhandlers and the rest of the community. Homelessness always has been, and will continue to be, one of the most important issues that our world faces. According to The Council of Economic Advisers, 17 out of every 10,000 people in the U.S. fall under the qualification for being homeless, with a large portion of that population relying on donations from people on the street via panhandling ("The State of Homelessness in America", 2019). A considerable amount of money exchanges hands through panhandling every day, with one study reporting that

panhandlers earn more than \$200 per day (Bose & Hwang, 2002). That same study also revealed that around 37.5% of their income was spent on either drugs, alcohol, or tobacco. Clearly, the money that panhandlers receive from donations is not always spent on useful items, especially since 25% of homeless people in America suffer from mental illness or substance abuse (Tarr, 2018). Not only are panhandlers spending money on unnecessary items that potentially propagate the cycle of homelessness, but the rise of e-commerce and cashless transactions is part of the reason that people carry less cash.

Over the course of the spring semester, our team developed and tested a prototype of our solution by creating a minimum viable product (MVP), and then iterating and improving the system based on results from testing. This project, called Tap2Change, is centered around an online application that will seek to mirror the process of giving money to panhandlers on the street, but with digital transactions instead of cash. There are existing platforms that allow for peer-to-peer transfers already, such as Venmo, Zelle, and Cashapp, but none of these services replicate both the anonymity and speed of giving someone a few dollars. To satisfy this, each user has a unique QR code that can quickly be scanned by potential donors with their smartphone camera. When a donor scans one of the QR codes, they simply enter the dollar amount they wish to give to the person and send it. In planning the technical development of our app, we consulted Yuan Tian, whose research involves user privacy and security. She strongly recommended that we avoid storing any money in the application itself because this poses a severe security risk. To satisfy this, we incorporated financial transaction APIs, Venmo and PayPal, to handle all the financial transactions on our application. Professor Tian also advised us to limit the amount of information required from a user to sign up for an account on the app, so we implemented single sign-on (SSO) with Google and Facebook in order to satisfy this. Given that this is a prototype, it

does not include all the final features that we intend to add. For example, we hope to provide more payment options beyond Venmo and PayPal so that our application can be used by the widest audience. We also are aware that not all homeless people have access to a smartphone or bank account, which would make it impossible for those people to use this prototype. Eventually, we plan to distribute cards with the panhandler's unique QR code on it so they can still receive donations. This sort of integration is difficult though, because the funds would have to be held somewhere before they get redeemed.

After discussing with Professor Tian and performing research, the team evaluated our potential solution concepts and selected a technology stack that allowed us to develop an MVP within the project's scope. The coding language we wrote our application in was Python because there are libraries we imported and used to simplify the work for us. Python is also widely used across the software industry, so there's a large community and documentation if problems arise. Django and Node.js were chosen to be the web frameworks since they are lightweight and the team has previous experience with both of them. For initial deployment, Heroku will be used since it is free and provides the availability and up-time that we need.

Conclusion

Overall, transitioning to a cashless society will benefit most of society as long as the proper considerations and potential problems have been addressed. As the research shows, we have already been moving away from using physical money, and a cashless solution such as CBDC or something similar provides the substitute necessary to replace cash. Even though there are downsides, such as requiring high levels of infrastructure and digital literacy, these are manageable and do not outweigh the many benefits. As seen with the technical project, there is a need for a form of digital currency that can be transferred offline and anonymously to people.

Looking forward, countries should prioritize the advancement of digital currency technology while also working to solve the problems of full implementation.

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