KOENIG & BAUER

Cash Works ... but it could work even better!

we're on it.

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Section 1: Introduction, executive summary & overview

1.0 Introduction

Cash works but it could work better. No other payment tool enjoys such a unique range of defining attributes, ease of access and use, simplicity or resilience. As humans, we can and we do depend on cash. Today cash and in particular, banknotes, represent the bedrock of economic stability, trade, social inclusion and freedom to exchange value.

Banknotes perform three essential roles in society:

- Transactional
- Store of Value
- Unit of account

We must always remember that banknotes are not used exclusively for transactional purposes. They also serve as a legitimate store of value and a unit of account that allows us to compare value and make consumer choices. Both of these roles of cash have significant societal importance. During times of uncertainty and even crisis, the resilience of cash becomes particularly evident as members of the public tend to store banknotes for later use in case of emergencies, when the ability to access or use other digital payment tools is compromised. Globally, it is difficult to measure the exact amount of banknotes that are used for store of value but a 2021 report from the ECB (The paradox of banknotes: understanding the demand for cash beyond transactional use - Alejandro Zamora-Pérez, ECB Economic Bulletin, Issue 2/2021) estimated that anything between 28-50% of Euro banknotes in circulation were being held as a store of value.

The societal importance of cash acting as a unit of account may be subtle but nevertheless, incredibly important. In many parts of the world, children learn to count using the price of items. It plays a fundamental role in our ability to learn and understand the concept of absolute and relative value.

This report addresses cash as a purely transactional tool and analyses the direct impact that the associated cash service system has on its demand. No attempt has been made to measure the indirect impact that the cash service system may have on its additional roles, mentioned above.

Today, the emergence of a growing body of non-cash digital payment tools has afforded consumers in some parts of the world an ever-growing range of choice in how they pay for goods and services. This has turned the spotlight onto payment tool efficiency and sustainability, questioning what role they will play in a crowded marketplace where all payment tools compete for a part of the same pie.

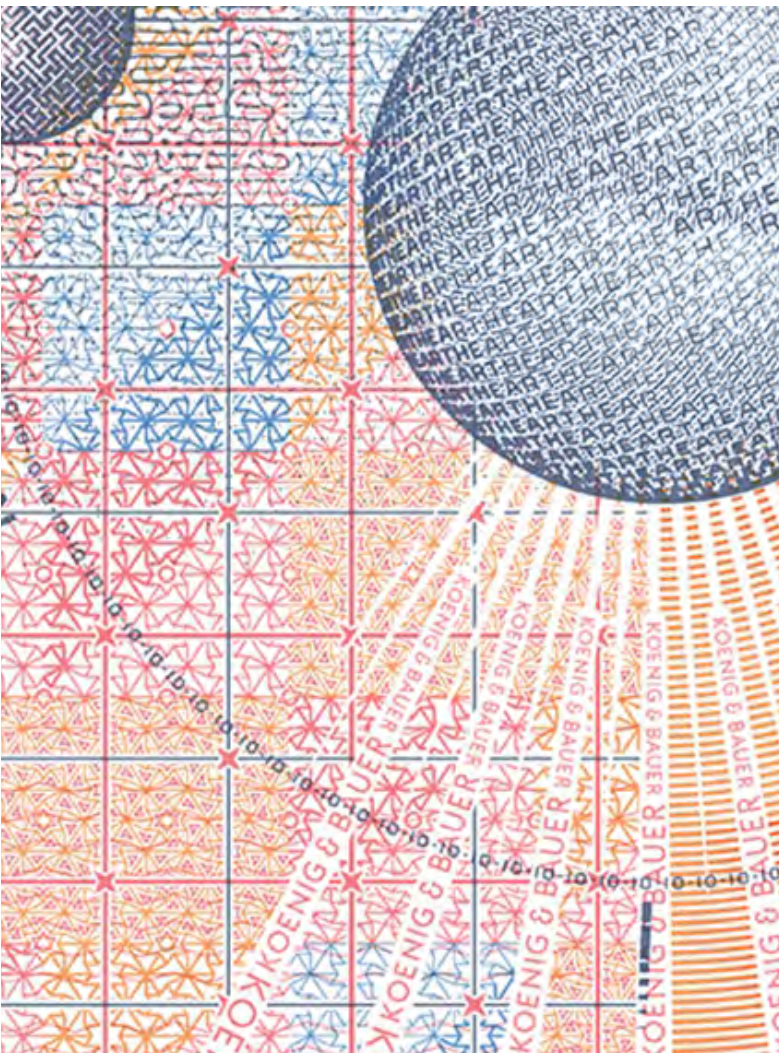
This whitepaper invites you to step back from the hype and confusion generated by the plethora of incessant reports on emerging payment tools and focus purely on cash and in particular, banknotes. What is right with them, what is wrong with them and how can we improve the way they are accessed, moved and used in society? We go straight to the point and assess with certainty and clarity, what makes banknotes popular in society, what role they will play in our ever-evolving digital world and how we can make banknotes and the banknote service system upon which it depends, more efficient and sustainable?

Eric Boissonnas - CEO at Koenig & Bauer Banknote Solutions

"Our goal is to open a cross-community dialogue on the evolution of cash. It is the beginning of a journey and an invitation to explore and discover by developing a better understanding of what options are available to reimagine and redefine the banknote and its associated service system. Future innovation in this domain will only be made possible through cross-community collaboration and the involvement of a wider range of actors than presently considered appropriate for such a discussion."

We are not there yet, but by collectively engaging in future-thinking around this white paper we believe that innovators can fill the gaps on the complex mosaic landscape of cash and in particular banknotes by connecting enabling technologies with current and emerging requirements.

We believe that data will become an enabler of change both in terms of Central Bank regulations and in terms of empowering the global cash community to radically change cash management processes by simply knowing where cash is, who needs it and how to connect supply with demand by sharing data. More precisely, we believe that it is possible to harvest data from the retail layer into a Central Bank regulated data ecosystem with programmable shared access by Cash Cycle actors.Access to this data by a controlled hierarchy of data consumers will allow true innovation to happen and enable the development of more sustainable and equitable Cash Cycle models



1.1 Executive summary

The banknote product and the associated design and manufacturing processes that go into making it have evolved significantly since the 1960's resulting in considerable reductions in manufacturing costs and ecological impact. Over the same time period, the banknote service system has also evolved, largely in response to an exponential increase in demand, driven principally by global GDP and population growth. To service the growing demand for access to banknotes, in compliance with Central Bank recycling regulations, the cash industry's response has largely been to automate the banknote recycling process. This activity takes place in centralised hubs and is supported by cash in transit services (CIT) moving banknotes to and from cash touchpoints within society.

As the true cost of cash in circulation becomes more evident and in particular, the question of 'who actually pays for cash?', many stakeholders are asking fundamental questions about cash sustainability in the future. Today, cash co-exists with countless alternatives in the highly competitive multi-payment tool ecosystem, affording the public not only choice but a host of other intrinsic and exclusive attributes such as universality of acceptance, finality of transaction and anonymity. In order for cash to continue to offer the public such unique functions in the future, the global cash community must ask itself one specific question; 'What are we going to do to improve the way cash is moved, accessed and used in society? '

Since the largest source of cost and ecological impact comes from the banknote service system and not the product, it makes sense to address this part of the banknote ecosystem in any endeavour to make cash more efficient and sustainable. Cash industry actors are working hard to make incremental improvements to the banknote service system and many successes are visible. But are incremental changes enough or has the time arrived for a fundamental revision to the way cash is organised and managed in society?

This whitepaper demonstrates that existing Cash Cycle architectures have been designed at a time when access to data on where cash is in society and how it actually flows from one touchpoint to another was largely absent, rendering it impossible to optimise cash movement and management which today, is spread across a highly fragmented cash management landscape.

Today, a family of technologies exist that enable the physical banknote product to connect with digital data ecosystems, providing an opportunity for Cash Cycle stakeholders and new innovators to completely reimagine and reinvent the way cash is managed, transported and accessed.

This whitepaper aims to provide fresh insights and possibilities by presenting this emerging family of 'bridging technologies' and providing concrete use cases to demonstrate how their application can result in quantum improvements in terms of the ecological footprint and the cost of cash in circulation.

Our ultimate goal is to ensure that the public continues to enjoy a high level of **payment tool choice** and that cash builds upon it's recognised set of user assets to evolve as an even more viable and **sustainable payment tool for all sectors of society** around the globe.

Julian Schubert - Head of Data, Vision, and Authentication Solutions at Koenig & Bauer Banknote Solutions

"The future of cash is so important to society and humanity as a whole that we simply cannot leave its destiny in the hands of any one group of stakeholders. An incredible amount of research already exists, pointing us in the direction of what needs to be improved or changed in order to make cash more sustainable. Thanks to this, we already know **WHAT** we need to do to build a bright future for cash but we do not exactly know **HOW** to do it.

This whitepaper is an invitation to engage and exchange with us on **HOW** we can affect the significant scale and scope of change required by connecting the physical banknote to digital ecosystems via bridging technologies."

1.2. Overview

Banknotes have been around for a very, very long time and the way they are used, moved and accessed has evolved in line with public needs and technological advances. To put this in context, banknotes in circulation have grown by over 400% since the introduction of the first ATM in 1967, when the world population was around 3.5 billion. Since then the global population has reached over 8 billion and global GDP has grown by an average 8% per year, all fueling demand for banknotes as people go about their day-to-day lives conducting transactions.

As demand for banknotes increased, Central Banks had to find a way to assure continuity of supply and access to banknotes while at the same time maintaining public trust and confidence in them, without incurring significant cost increases. The cash industry response to this massive growth rate in demand for banknotes, (and in compliance with Central Bank regulations) was to add layers of high speed/volume automation to replace manual processes.

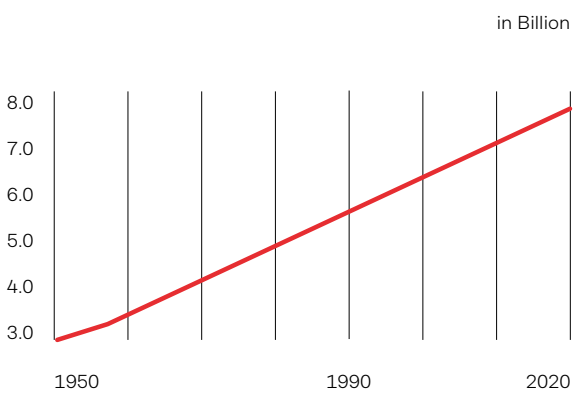
Due to the high cost of setting up and operating these automated infrastructures, they were centralised into hubs, later to be known as 'cash centres'. The centralisation of such activity into high volume hubs resulted in the need to transport high volumes of banknotes between the processing hubs and the retailer or commercial bank (including ATMs), thereby creating a new industry, that has grown exponentially since the 1960's called cash-in-transit (CIT).

Automation and centralisation of cash processing worked for several decades and supported the expansion of cash access and use points. In the late 1990's and early 2000's retailers and commercial banks began to analyse how much cash was actually costing them in their business. The subsequent realisation of the true cost of handling cash drove commercial banks and many retailers to favour non-cash payment tools where, regardless of what the absolute costs actually were, a more equitable and fairer repartition of these costs was promised by card issuers, turning the spotlight away from the absolute cost of cash in society to who actually pays for cash.

More recently the same type of analysis is being applied to cash but using a different set of metrics – ecological impact and sustainability. Through such analysis we are seeing largely the same results in terms of what is actually causing the main ecological impacts of cash in circulation since there is a strong correlation between the cost of cash and the ecological impact of cash in circulation.

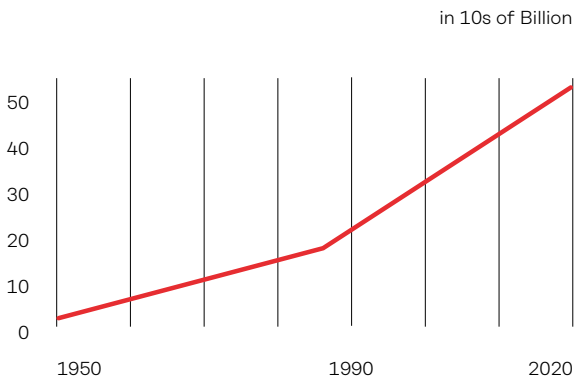
The research and analysis conducted on the cost and ecological footprint of cash since the 1990's has identified what the key drivers are and how much they actually amount to. We now have a very clear picture of what we need to do to improve the current situation but the real challenge remains to be resolved – How to do it? This gives our community and incredible opportunity to drive down the cost and ecological impact of cash at the same time, using a common approach that will ultimately result in a more sustainable and equitable future for cash and all of those involved in how cash is actually issued, moved, accessed and used.

Population, total



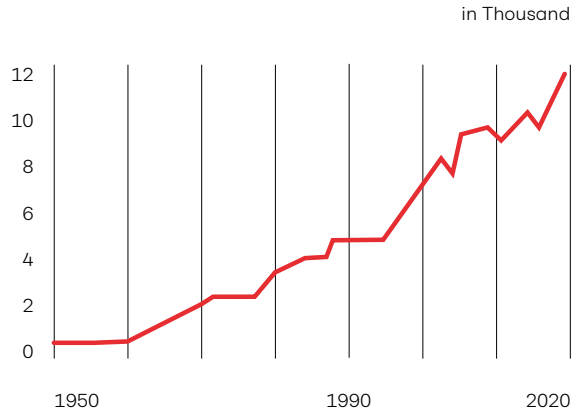
Source: World Bank statistics

Banknotes in circulation



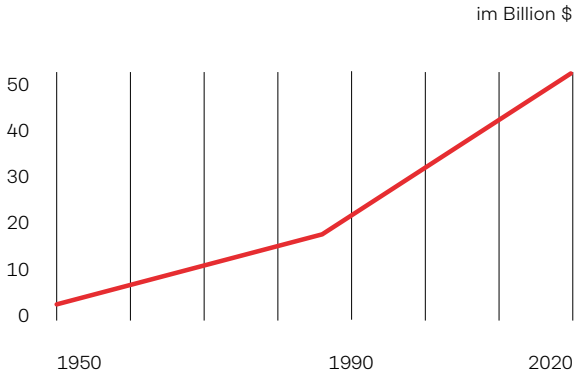
Source: Koenig & Bauer tracking data

GDP per capita



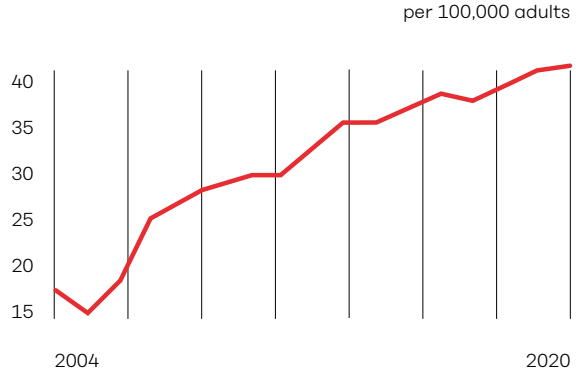
Source: World Bank statistics

CIT & cash management industry growth



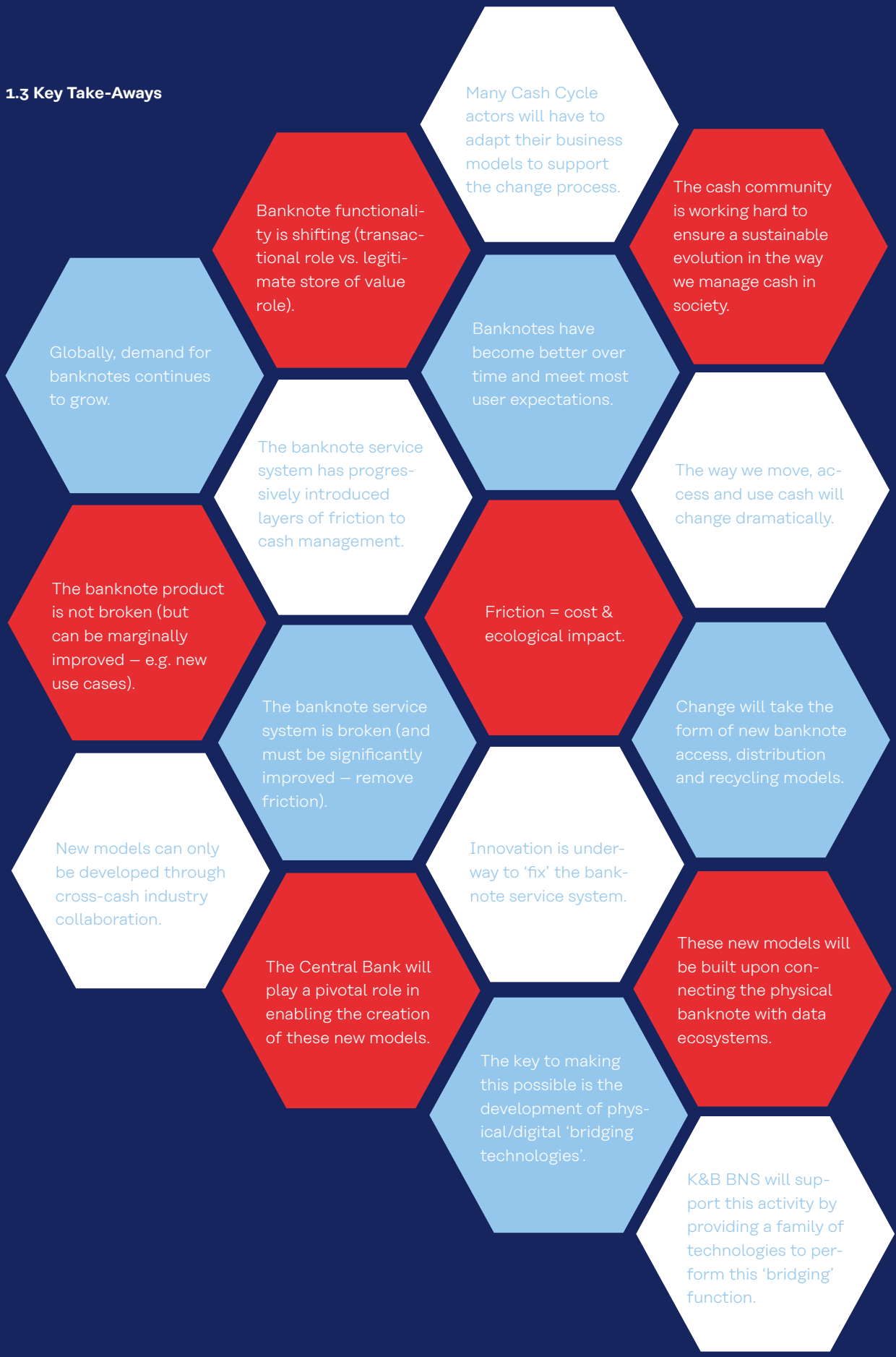
Source: consolidated cash management industry data

Automated teller machines (ATMs)



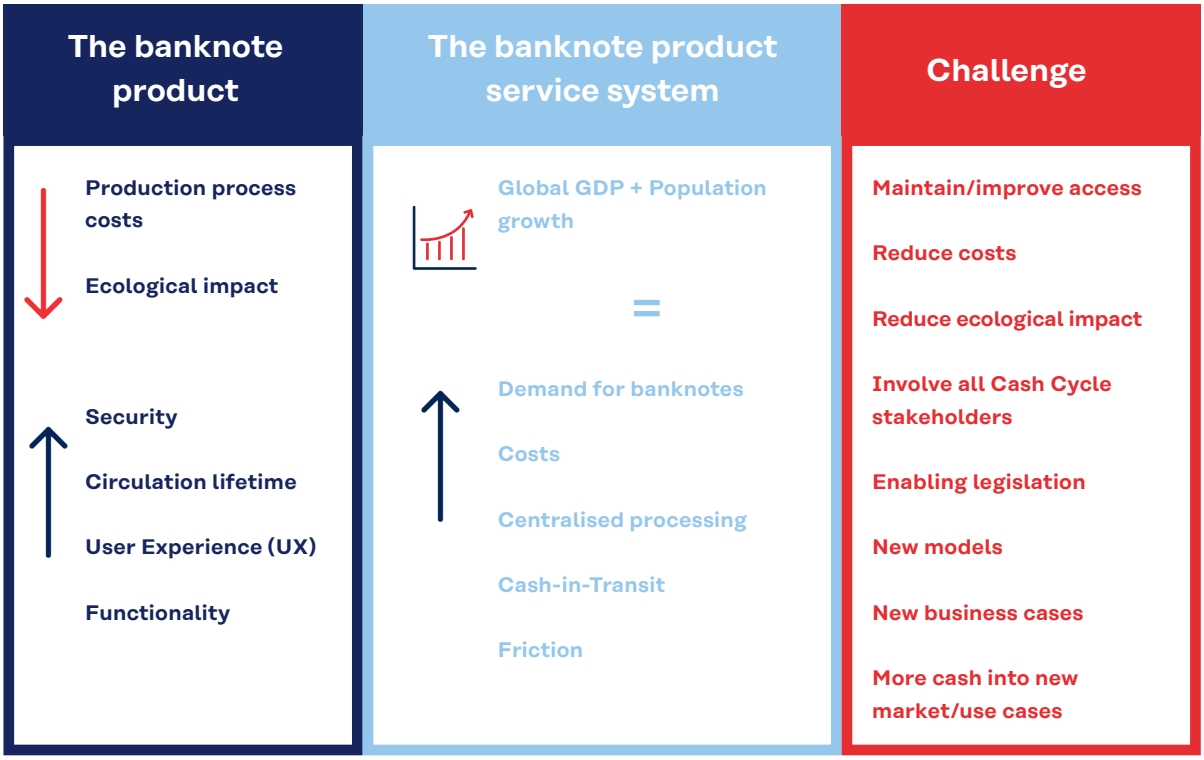
Source: World Bank statistics

1.3 Key Take-Aways

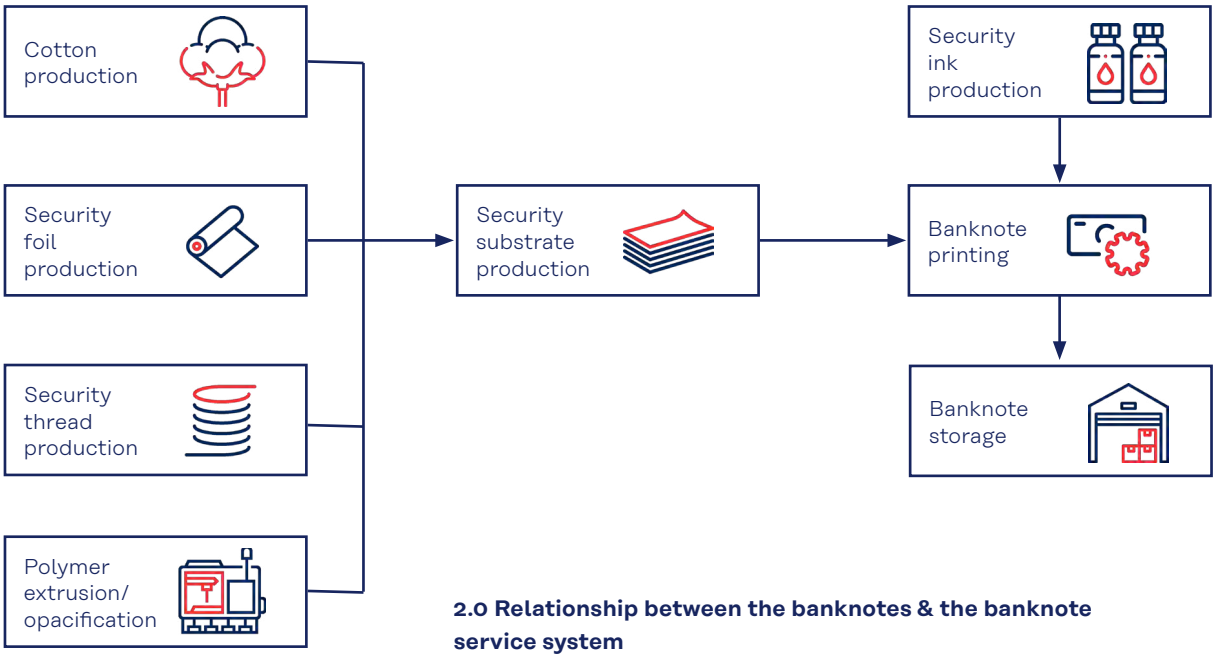


Section 2: The banknote product

Banknotes have evolved over time to meet specific needs & requirements. In many ways the type of evolution we can see in banknotes is a reflection of their use environment and the range of demands placed upon them by the banknote service system (Cash Cycle) actors, including the public. In this section of the whitepaper we examine the relationship between the banknote product and the banknote service system.



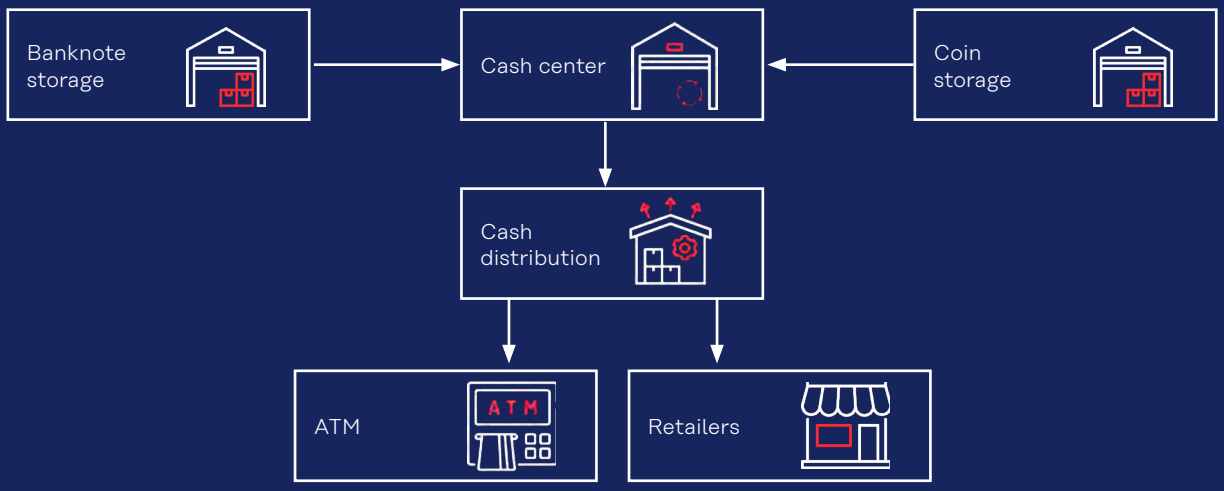
The banknote product:



2.0 Relationship between the banknotes & the banknote service system

In this section of the whitepaper we examine the relationship between the banknote product and the banknote service system (Cash Cycle) and analyse how they evolved to their current state by attaching some quantative and qualitative metrics to key performance indicators.

The product service system (Cash Cycle):



2.1 The product & the product service system explained

Our analysis will begin by separating the product (banknote) from the banknote product service system (Cash Cycle) upon which it depends to be accessed and used.

- The product (banknote)
- The product service system (Cash Cycle)

2.2 What is wrong with the product (banknote)?

By looking at the product first, the simple answer is; 'nothing is really wrong with banknotes'. In fact, today, banknotes are considered to be at the summit of their very existence. The real problem lies in how banknotes are moved, accessed and used, and the impact this has on key payment tool metrics such as cost, ecological impact and user choice.

2.3 What is wrong with the banknote service system?

'Nothing in life is free'. There will always be a trade-off between the benefits of providing cash in society and the costs involved in doing so. We must adopt a pragmatic approach when analysing these costs and ask relevant questions from completely different perspectives in order to stimulate balanced and healthy discussion. For example; 'what is the cost of cash and who actually pays for it? vs.; 'what is the cost of not having cash and who would suffer most if it was not easily accessible?'

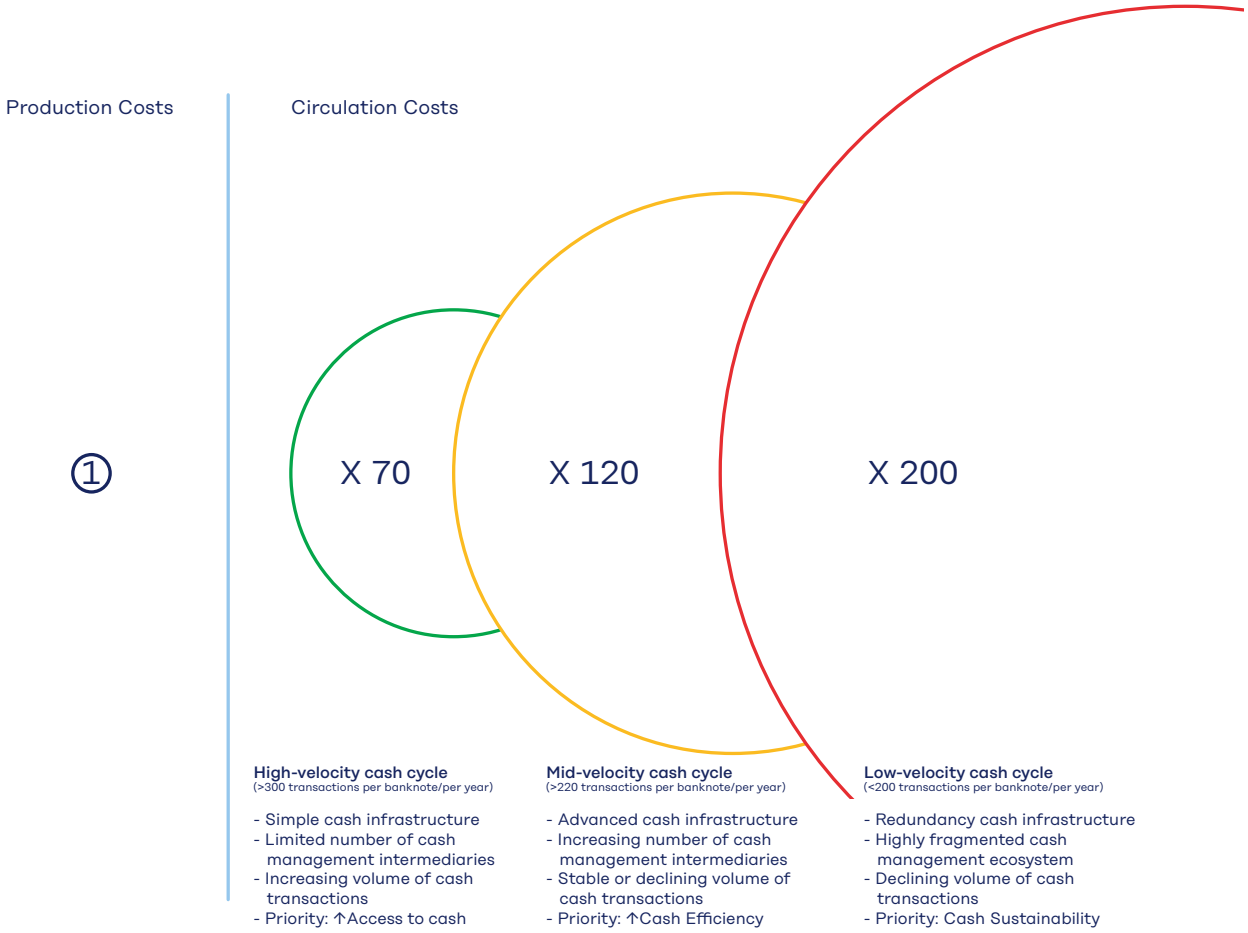
Today, a plethora of research papers exist comparing the cost of payment tools (economic, social and ecological cost). Germany and The True Cost of Cash (Jens Kleine, June 27 2013) suggested that the total cost of cash for the German private sector was 12.5bn Euros in 2011. A 2019 UK Access to Cash Review estimated the cost of cash to be in the region of £5 billion per year. A 2016 Visa study on the cost of cash in India estimated it to represent 1.7% of total GDP.

The cost of cash in the United States (US) was addressed in 2013 by Bhaskar Chakravorti & Benjamin D. Mazzotta in a publication by the Institute for Business in a Global Context suggesting that the total economic cost of managing cash in the US was $200 billion at a time when the US currency production budget was less than $1 billion. Studies by the same authors disclose the staggeringly high cost of cash in Mexico, Egypt and India at the time.

Other examples of such studies include the Bank of Canada's 2008-09 study, the Fletcher School's 2013 review, the Kansas City Fed's 2012 report and Economists Incorporated's 2014 paper. Although a 2018 report from IHL Group suggested the cost of cash, on average, was more than 9% of the transaction value, a European Commission study in 2015 concluded the cost of cash was 0.2% on average.

A more recent report from the European Central Bank in 2022 entitled; Occasional Paper Series, Costs of Retail Payments – an Overview of Recent National Studies in Europe, provides further insights on the social costs of cash as a payment tool. Extrapolating data from these reports and analysis of the cost of cash as a percentage of total GDP suggests that the total global cost of cash is today anywhere between $400 & $600 billion.

While this number refers to the total estimated cost of cash in circulation (coins and banknotes), we can narrow down the context by comparing the actual cost of producing a banknote to the average cost of keeping this banknote in circulation as follows:

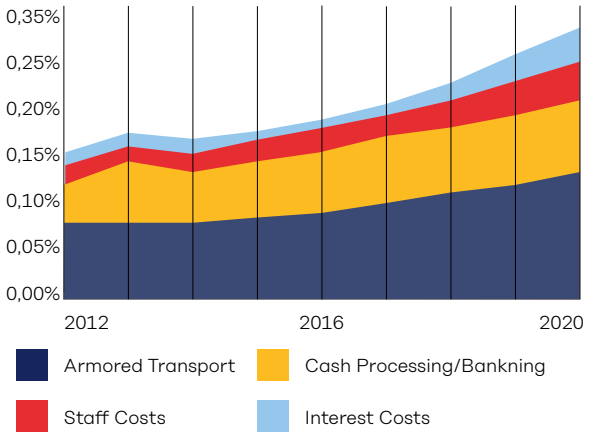


The above graphic also illustrates a correlation between Cash Cycle architecture, number of intermediaries involved and ecosystem fragmentation and the overall cost of keeping a banknote in circulation over its lifetime. The net result of how the cash service system is configured and operated has a direct impact on stakeholder priority pain points.

Perhaps the most concerning data on the cost of cash in circulation is not it's absolute cost but whether it is on the increase and who is paying for it. According to the CMPSI, the cost of cash is rising due to a range of drivers as illustrated in the graph on the right hand side.

Most forecasts suggest that the cost of cash in circulation will continue to grow in parts of the world where cash transactional use is declining and as redundancy creeps into established cash infrastructures, the average cost per transaction will increase significantly.

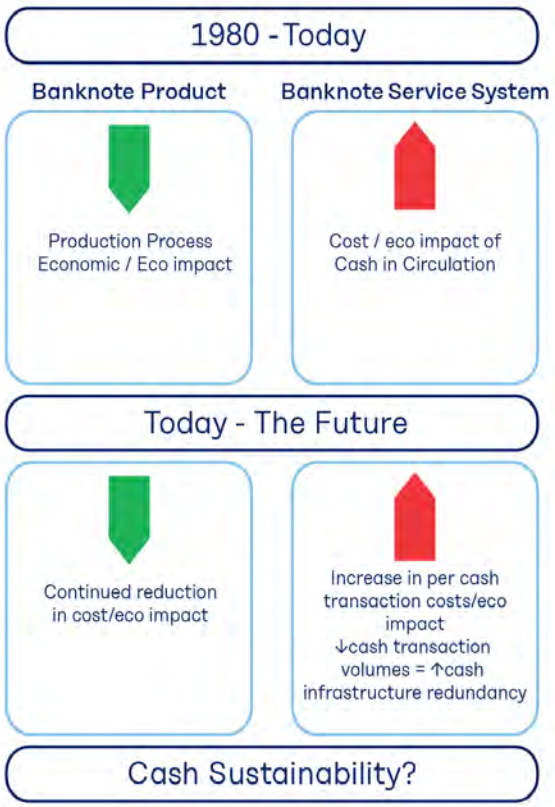
Increase in the cost of cash



Source: Fletcher School's 2013 Cost of Cash Review

The Fletcher School's 2013 Cost of Cash Review demonstrates that it is the poorest sectors of society who pay most to access and use cash. It concludes that around the world it is the unbanked who pay up to 4 times more to access and use cash due to their non-inclusion in banking systems and reliance on multiple intermediaries to access and transfer cash.

The below illustrations clearly demonstrate not only the significant difference in costs generated by the banknote product and the banknote service system but also show that the economic cost of cash is increasing relative to cash spending and that it is the poorest and most vulnerable sectors of society who pay the most to access and use cash – clearly an unsustainable trend that must be corrected.



2.4 What is right with the product?

Regardless of what people use banknotes for it is universally accepted that they are efficient, reliable, accessible and safe. In fact, according to the 2018 G4S Global Cash Report, cash and by extension, banknotes cover all of the features that consumers most value in a payment instrument, because:

- Cash is trusted as legal tender
- Cash has near 100% availability and reliability
- Cash is considered free of charge to use by the consumer
- Cash retains anonymity
- Cash offers direct settlement
- Cash offers a safe haven and fall-back
- Cash is tangible and helps with budgeting
- Cash offers inclusion in a national payments tool for marginalised sectors of society

2.5 Has the product improved over time?

The simple answer is yes. Banknotes have significantly improved their performance over the past two decades. As a product, banknotes have evolved to reach the summit of efficiency and functionality. Significant improvements in the key metrics that can be applied to banknotes to benchmark their performance have been observed over the past 10-15 years. These improvements are most notable in the following areas

- Security
- Circulation lifetime
- Production process costs
- Ecology
- UX
- Functionality

2.5.a. Security

A banknote must be secure in order to generate certainty, confidence and trust during a user transaction. Banknotes are remarkably secure and provide protection against the increasing threat of cybercrime that adversely impacts all non-cash payment tools. The report, Fraud in cash and electronic payments: taxonomy, estimation and projections, by Santiago Carbo-Valverde and Francisco Rodriguez-Fernandez, provides an empirical estimation of the value of fraud with cash and card payments for the period 2014–2018 in 52 countries in Europe, North America, Central and South America, Asia-Pacific and Africa. It concludes that fraud with cash has been decreasing 1.7% annually while fraud with cards has been increasing 16.2% annually.

Another metric that can be used to demonstrate the improvements in banknote security is counterfeiting. Globally, we are witnessing a downward trend in banknote counterfeiting as evidenced by multiple central bank statistics on the subject.

2.5.b. Lifetime in circulation

Another clear criterion applied to measure banknote performance is its lifetime in circulation. In simple terms, the longer a banknote remain functional in circulation, the lower the need to produce replacement banknotes to assure continuity of supply. The following innovations have greatly contributed to extending banknote lifetime in circulation:

- Polymer substrates
- Polymeric surface treatments (varnishing)
- Substrate fiber structural enhancement
- Multi-layer substrates
- Intaglio coverage

Polymer banknote substrate manufacturers claim that their technology can, on average, extend banknote circulation lifetime by 3 times. Similar results can be achieved through the use of multi-layer substrates incorporating polymer.

Surface treatment of banknotes (varnishing) along with the incorporation of more durable fibers into the substrate core have also significantly improved substrate resistance to soiling and mechanical degradation.

Even the intaglio printing process can greatly contribute to soiling resistance as the intaglio impression cylinder closes the pores on the surface during the calendaring process.

2.5.c Production process efficiency

The per unit manufacturing process costs of like-for-like banknotes has actually decreased by over 40% since the 1980's. This is largely due to the following:

Additional factors reducing the manufacturing cost of banknotes include:

- 'Designing for manufacturing' initiatives
- Smart design software factoring manufacturing parametres into design process
- Lean manufacturing initiatives at printing facilities
- Design prototyping and revision pre-production process
- First-time-right plate-making
- Efficiency initiatives at banknote sub-component suppliers (substrate, inks, foils etc.)

Metric	Impact	Improvement	How	Result
Supersize printing format	Increased yield per sheet (av. 32 banknotes per sheet to av. 50 banknotes per sheet	60%	Migration from standard to supersize format	Cost Reduction
Machinery Production Speed Increase	Increased from max 7,000 sheets per hour to over 10,000.	50%	Technology evolution	
Reduced make-ready time	More machine uptime	25–40%	Fast make-ready devices	
Reduced waste levels	Lower materials consumption	50%	On-line inspection technology	
Process improvements	Lower ancillary/plate consumption	30%	Plate-making/coating improvements	

2.5.d. Ecology

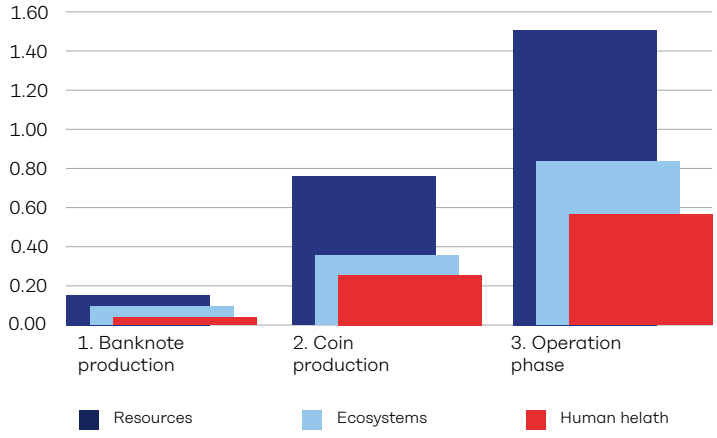
According to recent lifecycle assessment studies (DNB, Bank of England Banco de Mexico), the actual impact of the processes that go into making the product (banknote) represents a marginal percentage of the total ecological footprint of cash in circulation.

According to the DNB study, banknote production was responsible for 4% of the Cash Cycle's CO_2 emissions based on the IPCC Global Warming Potential (GWP) methodology.

Notwithstanding the fact the product represents a far lower impact than the support or service processes required to distribute and make it accessible, significant ecological improvements have been achieved. These include:

- → Reduction of electricity consumption
- → Reduction of waste and materials
- → Reduction of waste and resources

The environmental impact of cash



2.5.e. UX

Banknotes exist in a world of payment tool choice so the actual user experience associated with them is a key factor in determining user choice and demand. The banknote community was rather late embracing the body of science frequently referred to as perception science, which is a branch of neuroscience associated with how the human brain reacts to visual or tactile stimuli on the banknote landscape. Thanks to a considerable effort among the world's banknote designer community, perception science and the banknote user experience is now an integrated component in design thinking. A number of organisations now provide UX and banknote perception testing services to Central Banks around the world when developing new series designs.

2.5.f. Functionality

In parallel to assuring a human user experience during a banknote transaction, the banknote community also had to ensure that banknotes performed optimally when used in a transaction between a human and a machine. Globally, the automated ticketing and vending machine market has grown by an average of 11.7% CAGR since the 1990's and is forecasted to accelerate its growth cycle to approximately 16% between 2022 and 2027. More and more banknote transactions are being conducted between humans and machines and therefore banknote machine functionality is an appropriate metric to apply when benchmarking how banknotes have improved.

While cash is only one of the payment tools used in ticketing and vending, it is an important component in many countries. The automated banknote acceptor technology industry has worked hard over the past 15 years to develop robust yet cost-effective solutions to support the widescale deployment of automated cash payment terminals across the globe. This activity has been accompanied by the development of specific Machine-Readable banknote characteristics that could be pre-programmed to deliver highly individual responses to automated devices, resulting in a significant downturn in counterfeit banknotes being accepted by automated payment devices.

2.6 How can the banknote product be further improved?

While step improvements in banknote design, technology and content will continue to make the banknote perform better according to the above metrics, two distinctive areas exist today where the banknote could become a driver of significant change:

- Online payments (inc. direct remittances)
- Programmable payments

Currently Central Bank money such as banknotes and coins cannot be directly used for such activity and this precludes them from becoming part of a $1 trillion USD per year payments market with a CAGR of almost 40%.

For banknotes to enter the above market spaces, a fundamental rethink of how they can connect to digital ecosystems is required. However, preliminary research demonstrates that this is not only possible but that technology stacks already exist to make this a reality today. Whether banknotes eventually make an appearance in the online and programmable money marketspaces depends more on changes to existing regulatory frameworks and the development of clear value-adding use cases than on the technology required to make it happen.

2.7 Key Take-Aways

Section 3: The banknote service system – problem definition

Every product needs to be distributed in order to reach an access point for the consumer or user. Cash is no different but because it changes hands and remains in circulation for a long period of time, a highly specific service system, known as the Cash Cycle, has evolved to support it. This section of the whitepaper explores and measures what impact the banknote service system has on the overall cost and ecological impact of cash in circulation.

3.0 Co-dependency of the product and the product service system

In order to assess which payment tool might be the most efficient, cost-effective or sustainable in the long term we must consider both the product itself (the banknote) and the service system that makes it work. We must remember that all payment tools are products and they all depend on a product service system to operate.

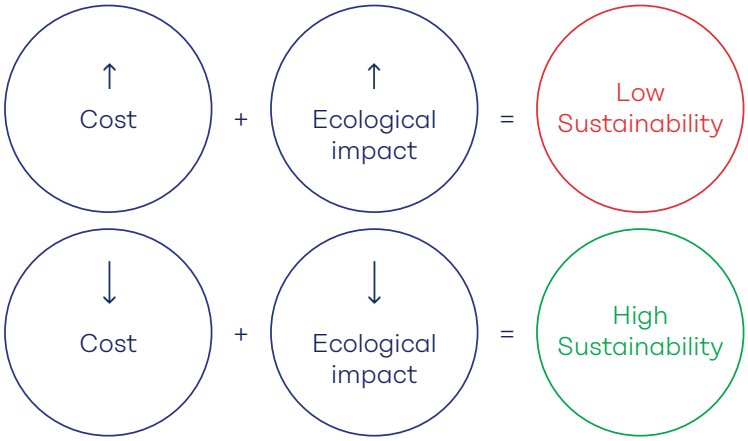
In the case of digital payment tools (cards, wallets etc.) they depend upon a digital product service system whereas in the case of banknotes they depend on a physical product service system. In fact, banknotes and coins are intensely physical products depending on an intensely physical product service system, which today is still remarkably disconnected from digital ecosystems that facilitate shared access by service system actors.

Actor	Role
Central Bank	Issuer
Commercial Bank	Access / Deposit
Retailer	Point of Sale
Cash Center	Recycling
Cash-in-Transit	Transportation
Public	User

3.2 Banknote service system actors and roles table

Traditionally, the banknote service system involves five key players: the Central Bank as the government issuer of cash, consumers and retailers as the primary users of currency, Commercial Banks as key distribution points and secure transportation companies to move cash from place to place. Today, the estimated 500 billion banknotes in circulation are moved around by these five key players to enable continuity of access and supply to cash users.

As a general rule, the more processes and actors involved in the banknote service system, the more friction will be created and consequently the higher the associated costs and ecological impact.



3.3. What is wrong with the product service system?

This question can be answered in one simple word; 'Friction'. This term relates to the increased cost (economic and social) and ecological impact associated with cash usage as it passes through the processes executed by the various Cash Cycle stakeholders in order to ensure banknote access and supply in compliance with Central Bank guidelines, their own business model and available technology.

3.4. How did the product service system become broken?

In many parts of the world, the banknote product service system (Cash Cycle) has also evolved to meet the changing demands of stakeholders involved in making cash accessible and in compliance with Central Bank regulations and even national legislation.

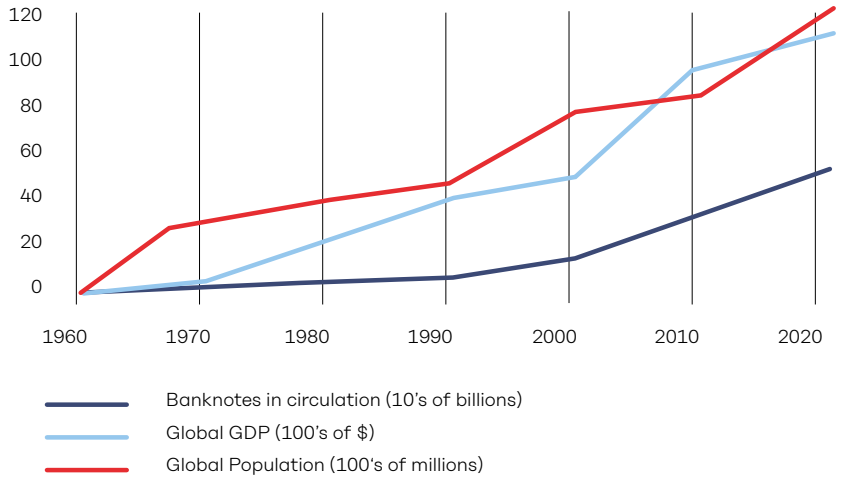
But unfortunately, this product service system and the latent inefficiencies, costs and ecological impact generated by it, are having an adverse effect on the future sustainability of the product; cash.

The below table clearly illustrates a correlation between time, technology evolution and friction. It should however be noted from the outset that the increase in automation was absolutely necessary in order to cope with the increase in demand for cash during the past 120 years.

Period	Trigger	Description	Level of Automation	Level of Friction	Cash Distribution Path
1900's – 1960's	GDP/pop.growth	Simple 2-way cash	OOOOO	OOOOO	Central Bank to Commercial Bank
1960's – 1980's	ATMs	ATM enabling	●OOOO	●OOOO	Central Bank to Commercial Bank to ATM
1990 – 2000	High speed sorting	Centralisition of recycling	●●OOO	●●OOO	Central Bank to cash center to Commercial Bank to ATM
2000 – 2010	Denomination specific distribution channels	Utilisation of retail layer	●●●OO	●●●OO	Low-retail/mid-ATM/ high Commercial Bank
2010 – 2020	Profileration of clean note policies	↑ Demand of integrated cash management services	●●●●O	●●●●O	Cash management Company controlled
2020 – Today	Cost/ecology/access/ acceptance	Brink of major change	●●●●●	●●●●●	Retail layer recycling

There is a direct correlation between the increased use of automation in the banknote product service system and the cost/ecological impact of cash. As costs increased, and most importantly, the issue of "who really pays for cash?" was addressed, the door to alternative payment tools was thrown wide open.

The transfer of the real costs of cash away from the Central Bank to the retailer and Commercial Banks created an inequitable burden of costs for society and ultimately, forced these Cash Cycle actors to explore the advantages of promoting non-cash payment tools.

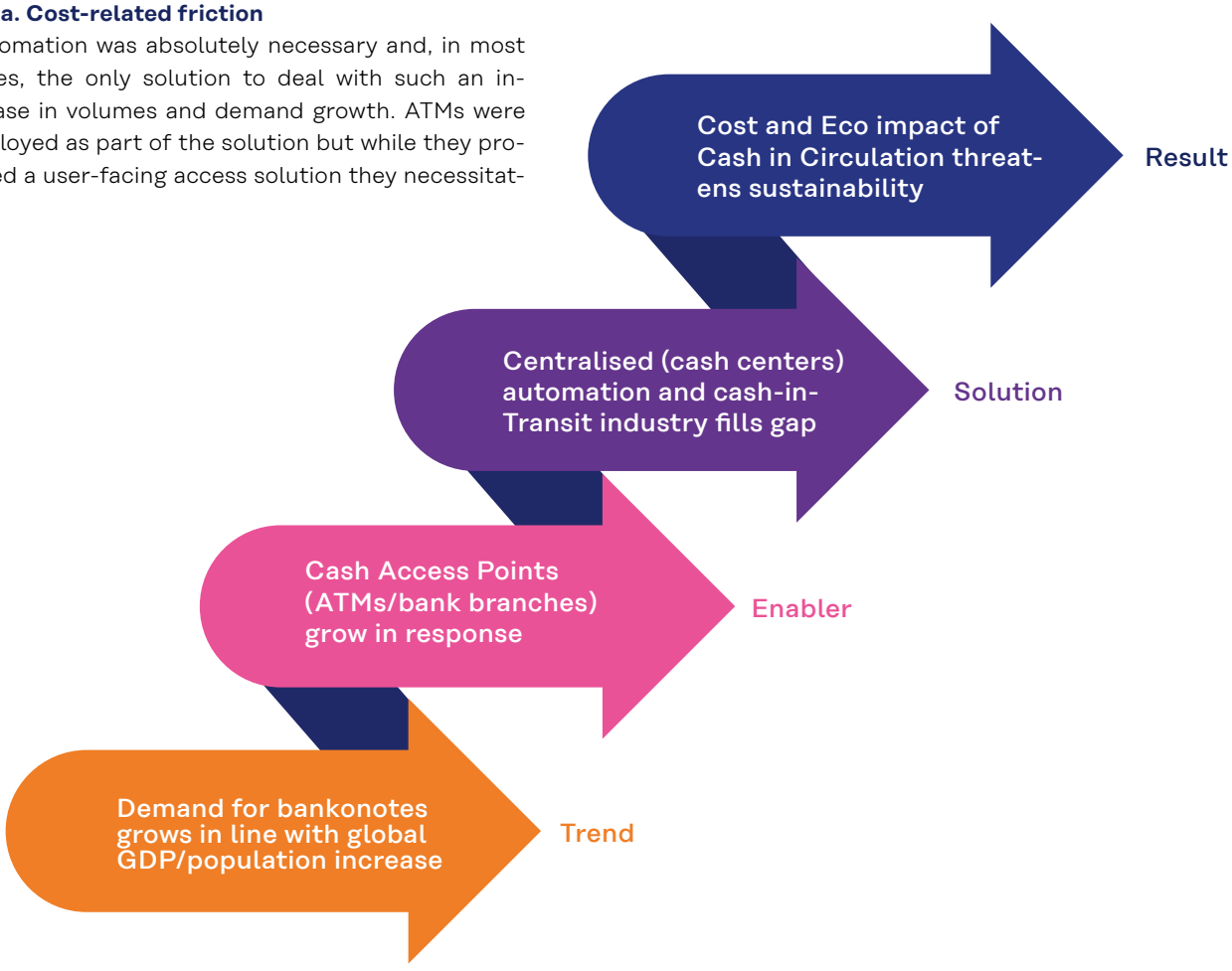


While certain macro and micro factors such as inflation and availability of payment alternatives may account for small parts of this dramatic increase in demand, it has been principally driven by global growth in population, GDP and transaction volumes as illustrated by the graph below.

3.4.a. Cost-related friction

Automation was absolutely necessary and, in most cases, the only solution to deal with such an increase in volumes and demand growth. ATMs were deployed as part of the solution but while they provided a user-facing access solution they necessitated an intensive support process and infrastructure that had a significant impact on both the cost of and ecological impact of cash in circulation, and we are still dealing with this inherited friction source today.

As friction layers were progressively added, the cost of cash in circulation increased dramatically since the 1950's.



3.4.b Ecology-related friction

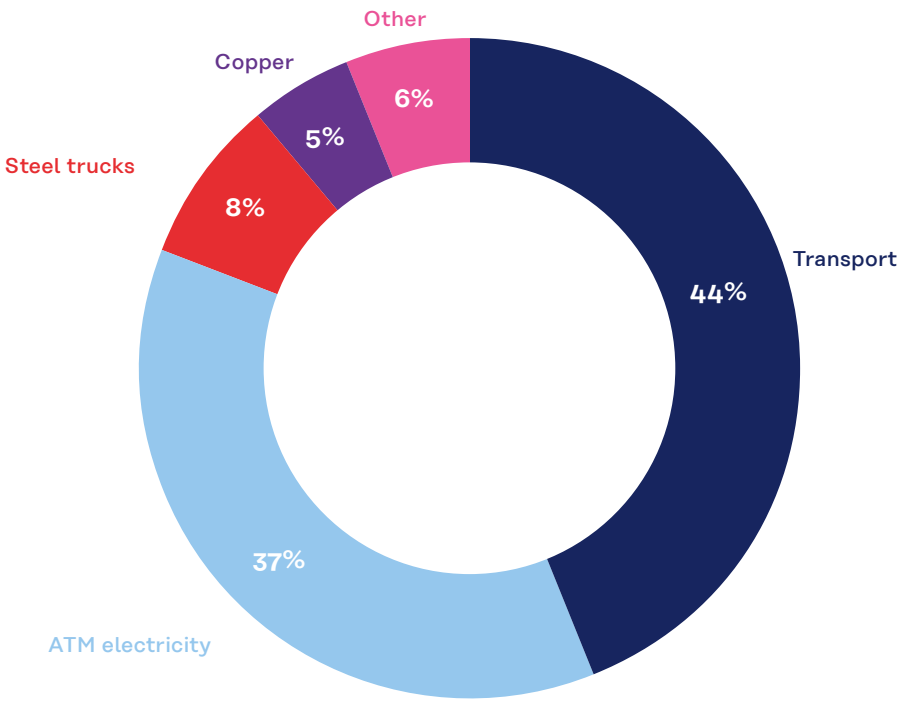
In October 2018, the Dutch National Bank (DNB) performed a Life Cycle Assessment of the Dutch cash cycle and concluded that the Global Warming Potential (GWP) of the cash payment system amounts to 17 million kg of CO_2 equivalents, which represents 0.009% of the GWP of the Netherlands. The three main identified contributors in the Cash Cycle were the production of coins, cash transportation and the operation of ATMs

In December 2020, LINK UK published a report enetitled; 'UK cash distribution and the carbon footprint' aimed at addressing the future of cash from a sustainability and ecological perspective. The report confirmed the findings from the Dutch study, demonstrating that the ecological footprint of cash comes principally from the operational phase, most notably ATM energy consumption.

In late 2021 Reconnaissance International published a study entitled; Cash – A Roadmap to Sustainability. The study confirmed the main points outlined in this whitepaper. Citing the original research from the Dutch National Bank 2018 study, the report tells us that the operational phase has the largest impact on climate change (88% according to the DNB study), with transport and ATM electricity as the main contributors.

It is also interesting to note that approximately 60% of Cash in Transit transport activity is dedicated to refilling ATMs with banknotes. The other 40% is to supply retailers with notes and coins, of which the latter accounts for c. 20%.

Relative contribution to total CO_2 equivalents per unit process:



Source: Cash – A Roadmap to Sustainability , 2021

3.5. So What exactly is causing friction?

The answer to this is simple; the centralised model of cash management whereby cash is transported from user touchpoints (retail/commercial banks/ automated payment devices etc.) to centralised processing hubs (cash centres) and then transported back to user touchpoints points.

3.6. Friction points

ATMs

ATMs are an essential component in any cash cycle, facilitating easy access to cash by the public. Paul Volcker once stated that; 'the ATM was the only financial innovation that had improved society' (Volcker (2010). However, the service system required to support ATM operation is highly problematic from both a cost and ecological perspective. Nevertheless, they are a key dynamic in maintaining demand for cash.

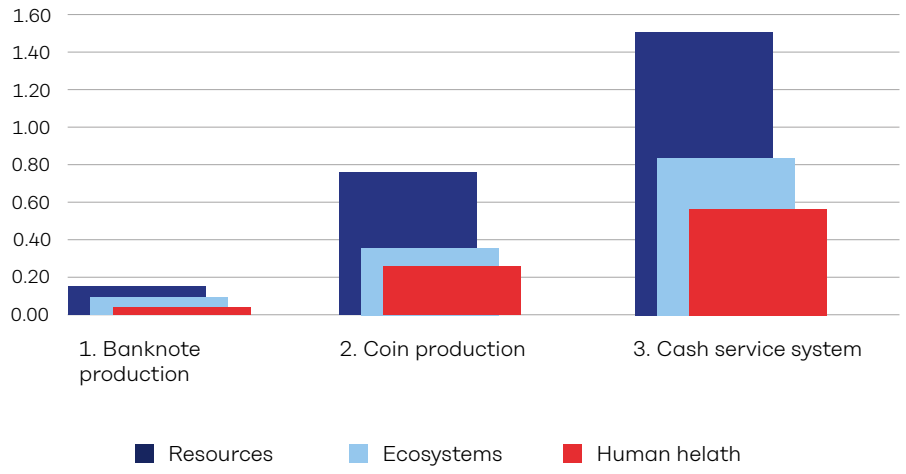
Research clearly demonstrates a direct correlation between the availability of access points to cash and demand for cash. If access is reduced, demand will most probably, also reduce and today we are seeing clear examples of how reduced access to cash is forcing people to switch to alternative payment tools around the world.

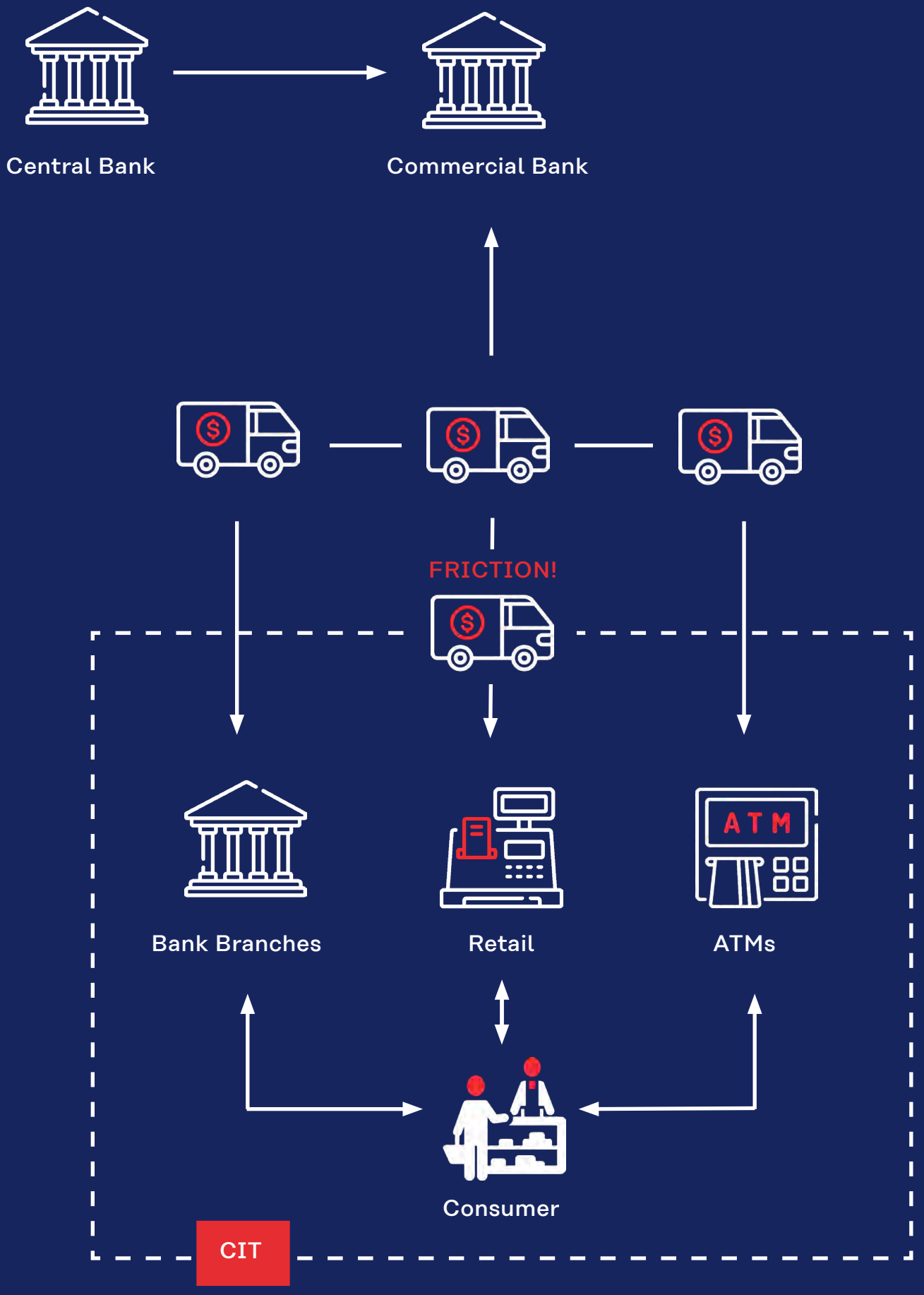
Today, there are approximately 3.2 million ATMs in operation globally with a significant disparity in ATMs per 100,000 head of population between developed and emerging nations (e.g. Canada 210 ATMs per 100,000 vs. Ethiopia 0.46 per 100,000). While ATMs were welcomed by all Cash Cycle stakeholders as a revolution in terms of how banks are organised for the distribution of cash, they did require a significant infrastructure to function including:

- Cash replenishment services and inventory monitoring
- ATM cassette pick-up
- Cash centre ATM cassette processing and balancing
- Cash centre banknote processing to FIT criteria
- ATM cassette refilling
- ATM cassette delivery and/installation

The aforementioned 2018 DNB study demonstrated that almost 60% of Dutch Cash-in-Transit activity was dedicated to ATM supply management.

The environmental impact of cash:




Central Bank
Commercial Bank
FRICTION!
ATM
Bank Branches
Retail
ATMs
Consumer
CIT

In countries with a high installed base of ATMs per 100,000 inhabitants, the cost incurred directly and indirectly to run this ATM network may represent the largest single component in the cost of cash in circulation. Recent Life Cycle Assessments by major Central Banks (Dutch National Bank, Bank of England, Banco de Mexico) also disclose the incredibly high ecological impact generated from operating an ATM network.

Commercial bank branches

Commercial Bank branches also represent a significant component in the cost of cash in circulation. In an effort to reduce the cost of providing cash services at Commercial Bank branches, some banks are either designating their branches as 'non-cash branches', focusing on non-cash services to generate revenue or simply closing their branches. The following graphic depicts the global decline in Commercial Bank branches since 2016.

Cash management companies/CIT's

Moving, recycling and pre-conditioning cash for user access falls largely into the hands of cash management companies who usually also assure the associated Cash-in-Transit service.

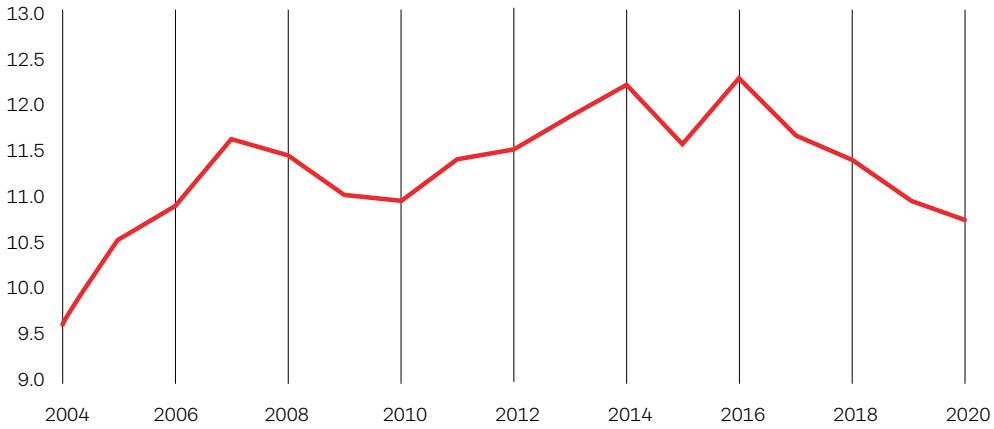
In 2020 the global cash management services market was estimated at a little less than $ 20 billion and forecasted to grow to $ 33 billion by 2030. Cash Management services are a core component in moving and making cash available to society. While cash management services are operated by private enterprise in many parts of the world, it is important to note that in many large countries this service is still assured by state or semi-state organisations.

Our research suggests that the combined cost of cash management and CIT services equates to approximately 14% of the total cost of cash in circulation. If we add associated data infrastructures, CIT-to-bank reconciliation and fees, this will increase to just under 20% of the total cost of cash in circulation.

3.7. What makes friction inevitable? Regulations, compliance and data absence

Friction sources have become a necessary component in the Cash Cycle since most processes have been developed in compliance to Central Bank recycling regulations governing both banknote authentication and fitness/quality. The global cash community has responded to such regulation by developing robust and resilient national cash infrastructures to support cash access and use. In recent times the cash community have been driving significant improvement in how cash is organised in society but to a certain extent, many initiatives have been limited in terms of realising their true potential by such legislation.

Commercial bank branches (per 100,000 adults):



Source: World Bank statistics

While in some parts of the world banknote recycling regulations and frameworks are highly descriptive affording a certain degree of latitude to cash processing and cash management organisations to innovate and improve processes, in many parts of the world these regulations are highly prescriptive, allowing very little space for introducing change.

What is common in most national Central Bank 3rd party Clean Note Policy enforcement and authentication regulations is that they emerged approximately 15-20 years ago, when very few alternatives existed to high capacity automated recycling at cash centers.

Today the situation has significantly changed. Technologies exist to allow full delegation of banknote recycling activity (authentication & fitness/quality) to the retail layer via a mix of decentralised community cash hubs (incorporating SmartSafe and similar technologies) and even to entrust retailers themselves to execute this activity.

In essence, it is possible to conduct the same authentication and fitness checking at the retail layer as that executed in cash centers, thereby significantly reducing the need for CIT services and centralised banknote recycling. However, in order for this to happen, Central Banks must be prepared to revisit the subject of recycling regulations and adjust these according to progress in technology and how this progress can have an immense positive impact on the overall cost and ecological impact of cash in circulation.

We believe that data will become an enabler of change both in terms of Central Bank regulations and in terms of empowering the global cash community to radically change cash management processes by simply knowing where cash is, who needs it and how to connect supply with demand by sharing data.

More precisely, we believe that it is possible to harvest data from the retail layer into a Central Bank regulated data ecosystem with programmable shared access by Cash Cycle actors.

Access to this data by a controlled hierarchy of data consumers will allow true innovation to happen and enable the development of more sustainable and equitable Cash Cycle models. The next section of this whitepaper will demonstrate how.

3.8 Key Take-Aways

Section 4: Fixing the banknote service system

Many of the initiatives currently underway to improve the banknote service system are based upon existing business models and represent incremental or step-changes. While this makes perfect sense within the context of the existing limitations to change, such as Central Bank recycling regulations, perhaps the time has arrived to think differently and explore a radically different approach to changing the way cash is managed in society.

This section of the whitepaper will demonstrate how a fundamental revision of Cash Cycle processes is possible and how it can benefit all Cash Cycle actors, providing cross-community collaboration and data access/sharing becomes a reality.

4.0. Diverging approaches to solve the same problem:

The global cash community is already working hard to improve the way cash is moved, accessed and used in society. We can categorise such initiatives into 3 things

1. Reorganisation of existing product service system
2. Real innovative and disruptive technologies
3. Creating a new product service system model

All have merit and activity to date by new and existing stakeholders is laudable but perhaps the time has arrived to think differently?

4.1. Reorganisation of existing product service system

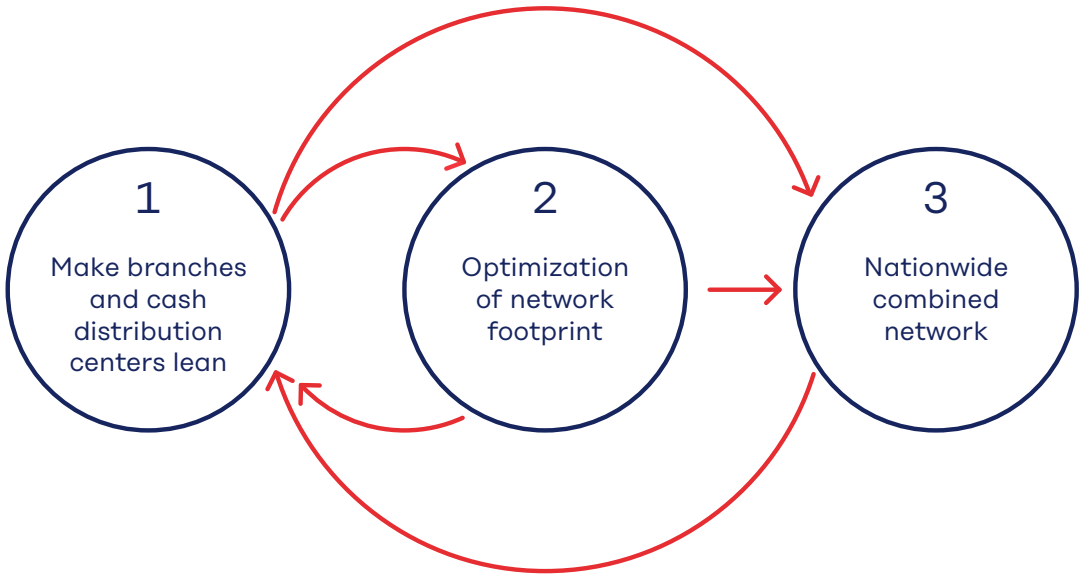
The Global Consulting Group Mc Kinsey published their whitepaper entitled Attacking the Cost of Cash in 2018 where they reached similar conclusions as those outlined in this whitepaper concerning the need to significantly improve the cash/banknote service system to ensure that cash remains a viable and competitive payment tool. In their report they identified three key levers or areas where banks can play a role to save the future of cash as follows:

- Making cash operations lean (cash distribution centers and branches)
- Optimising bank-owned distribution networks (ATMs and branches)
- Pooling resources with other banks to form a shared cash-handling network

Mc Kinsey estimated that most banks can reduce their cash costs by as much as 30% by applying lean principles to eliminate waste and maximise productivity in distribution centers, inventory management, and transportation.

The biggest improvement in efficiency comes from the elimination of repeated steps in the replenishment process, primarily in cash distribution centers, where 40% of steps are checks and controls (for example, counting and recounting notes). Mc Kinsey also estimated that significant improvements can be achieved by improving the data infrastructures around cash forecasting and inventory management. Their research shows that nearly half of banks rely on manual calculations (e.g., spreadsheets) to forecast cash needs for branches and ATMs.

The third lever, creating a national ATM utility, is the logical extension of the second and becomes increasingly relevant as cash usage falls and fixed costs rise relative to total costs. Pooling resources in a consolidated or joint network can ease the economic burden of maintaining the last ATM in an isolated locale where traffic is suboptimal. Shutting down a branch or ATM in a small town might not be significant as long as alternatives remain, but shutting down the last ATM in town could prompt severe public reaction.



4.2. Real innovation & disruptive technology

Rather than building upon and improving how the existing cash service system works, real innovation implies new technologies and processes to by-pass existing structures and actors to create a more efficient process thereby rendering many traditional actors redundant or less important

The community of actors most likely to lead this type of activity iy frequently referred to as the CashTech community. CashTech is the encounter of cash and technology. It brings together innovative companies who leverage software and modern communications technology to improve cash services: access to cash; acceptance of cash; and the efficiency of the Cash Cycle for all stakeholders. In a 2020 CashEssentials webinar, almost two thirds of participants indicated that they expected CashTech start-ups to drive innovation within the Cash Cycle. (see chart below).

CashEssentials goes on to provide the following definition and role of CashTech;

CashTech isolates pain points in the Cash Cycle and offers solutions to make it sustainable going forward. CashTech is about augmenting, not diminishing, the payments system. As banks move away from cash, cash is moving away from banks. CashTech puts retailers and small shops en route to become alternative, supplementary channels for the distribution and collection of cash.

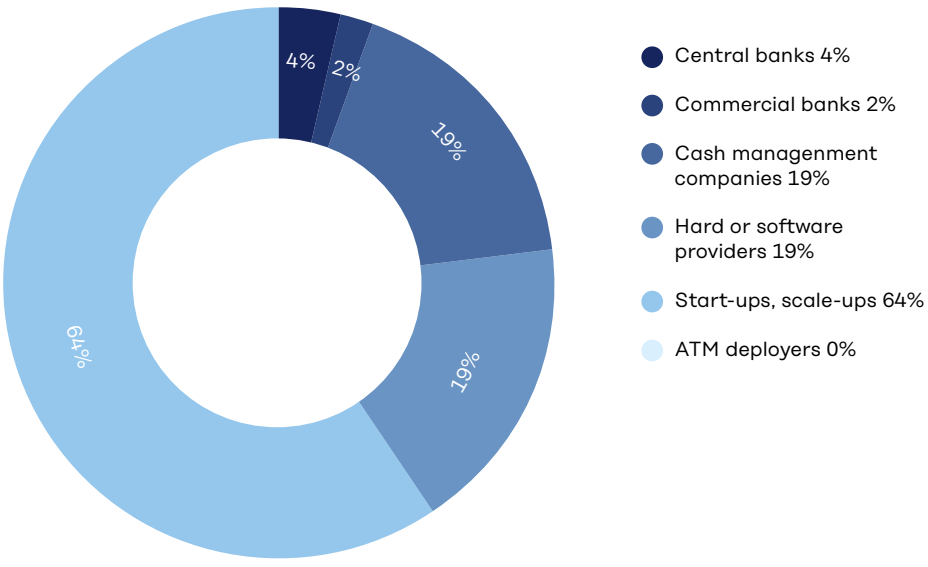
CashTech is about making the system more efficient for all, about finding a set of broad and inclusive solutions that, eventually, can be tailored to fit all stake-holders."

4.3. Creating a new product service model (Cash Cycle)

While the efforts currently underway by all Cash Cycle stakeholders to improve the banknote product service system are laudable and achieving some impact, this paper argues that step improvements are not enough. A fundamental rethinking around how cash is managed in society is required and the new models emerging from this exercise may not be based upon the past but could embrace several disruptive technologies to create entirely new models.

However, this will require a true cross-community initiative, involving Central Banks, Cash Cycle stakeholders, law makers and even the banknote designer and printer. Three critical areas that have the potential to enable significant Cash Cycle improvement, reducing both the cost of cash in circulation and its ecological footprint are:

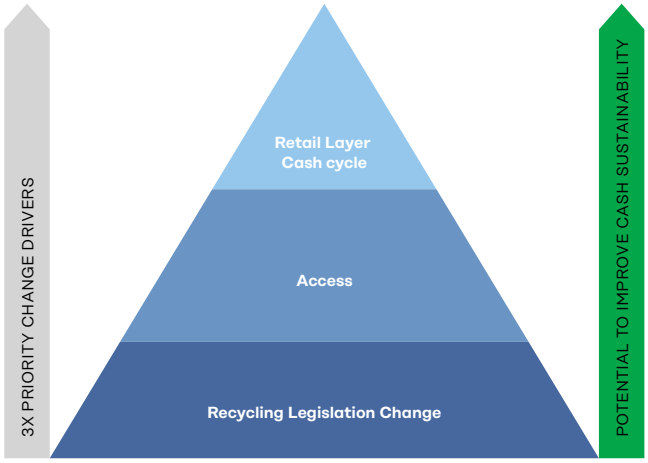
- Legislation change
- Access to cash
- Retail layer Cash Cycle



4.3.a. Legislation change

To a certain extent traditional Cash Cycle models whereby cash is transported to and from cash touchpoints in society are the result of Central Bank regulations and rules concerning banknote recycling, authenticity and fitness checking. Compliance with these regulations coupled with the high volume of banknotes that must be authenticated/fitness-checked before being reissued has resulted in the centralisation of such activity at cash centers and the associated cash-in-transit process. While this process works, it is not optimised and generates significant Cash Cycle friction.

Legislation change is an absolute requirement for change in the Cash Cycle. New technologies make this possible while maintaining similar or even better levels of control on the health and security of banknotes in circulation. By delegating this activity down to the retail layer, the significant cost and ecological impact from cash centre-based banknote processing can be reduced as stakeholders and innovators work together to develop new models based upon retail layer banknote recycling.



4.3.b. Access:

The secret to the success of ATMs is convenience. They were, until very recently, always available, nearby, open for business and full of cash. But some other touchpoints within society can be described in the same way. Retail stores, for example can in most ways meet the classic role and purpose of ATMs. This is what we call Cash-in-Store.

Cash-in-Store initiatives can be categorised as follows:

- Cashback
- Virtual ATMs
- Cash pick-up points
- Cash delivery

Why have Cash-in-Store initiatives not been more popular:

- Low public demand
- Low stakeholder incentivisation
- Absence of Commercial Bank-driven promotion
- Questionable retailer benefits

Research from the European Central Bank illustrates that less than 7% of cash in Eurozone is accessed via Cashback and other Cash-in-Store initiatives. Clearly this demonstrates enormous potential to orientate more consumers towards shifting consumer perceptions of how cash can be accessed while at the same time making cash access a profitable service for all retailers, big and small.

4.3.c. Retail/community layer cash management

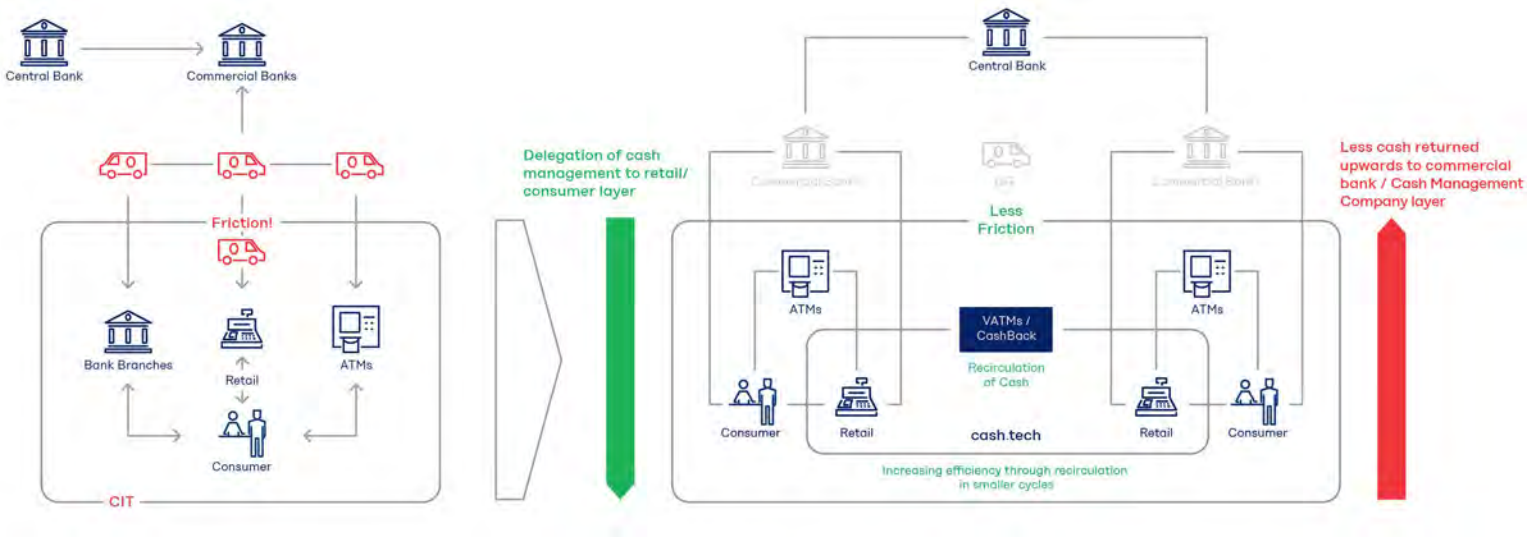
The real issue of retail level cash management is about creating a local and viable balance between 'cash out' and 'cash in' and in particular denomination balancing, since different retailers with different product offerings will require different denominational splits.

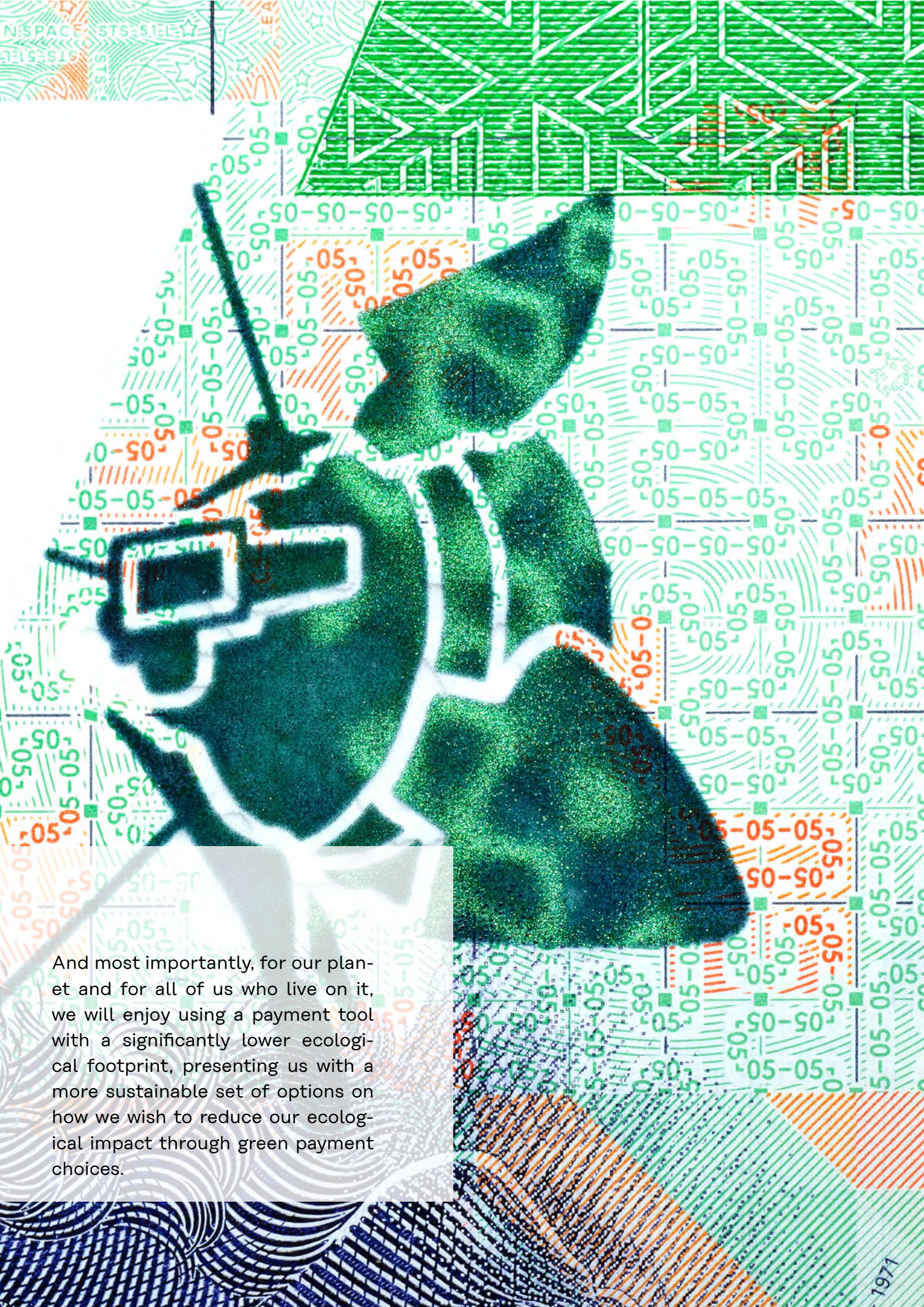
To date, and in accordance with Central Bank regulations, this issue has been successfully managed by cash management companies who process cash via centralised hubs serving a particular region or concentration of retailers/bank infrastructures. Ultimately this involves collecting cash, processing cash, reconciling cash amounts to retail accounts and delivering cash back to the same points.

However, the concept of a community Cash Cycle eliminates or significantly reduces the need to transport cash in dedicate vehicles to cash processing hubs. The community Cash Cycle model is based upon a local deposit/withdrawal centre where accredited retailers can deposit their end-of-day cash, reconcile the physical deposit with the associated data, credit their bank account and withdraw cash necessary to facilitate their next day of business.

The model is based upon the premise that different retailers will experience different inflows and out flows of cash on different days, helping to create a period of self-sufficiency between retailers with a far less frequent need to inject fresh cash into the process from external sources via a cash management company.

Established technology such as mobile banknote authentication Apps, SmartSafes, connectivity to retailer bank accounts, retailer network connections to view cash availability and denomination counts effectively ensure a continuous circular functioning of a retail layer/community cash cycle model. Interfacing the SmartSafe devices to a cash management company data ecosystem will allow these companies to provide cash/denomination top-up and collection services in a more local, efficient and sustainable fashion, thereby significantly reducing costs and ecological footprint.





And most importantly, for our planet and for all of us who live on it, we will enjoy using a payment tool with a significantly lower ecological footprint, presenting us with a more sustainable set of options on how we wish to reduce our ecological impact through green payment choices.

4.4. The win-win philosophy

For any initiative of this scale to succeed it must present a clear value-proposition for all stakeholders in order to secure buy-in and support. As mentioned earlier, this is a vital ingredient for success since the type of far-reaching change required will only be made possible through intensive cross-community collaboration and even the inclusion of new innovative players in the process.

The beauty of the proposals outlined in this white-paper is that they truly present a win-win value-proposition for all stakeholders. Whether we apply metrics to measure cost reduction, efficiency improvements, societal benefits or ecological impact reduction, the proposals contained in this white paper will. Create value for all Cash Cycle act
ors as follows:

- For the consumer or public, this will have an incredibly positive impact as access and inclusion for all sectors of society can be improved.
- For the retailer, lower costs of handling cash and an increase in product/service offering resulting in higher in-store traffic, improvements.
- For the commercial bank, they can pursue their exiting objectives of operational cost reduction while ensuring clients have continuous access to cash.
- For the CIT, new opportunities to develop and operate new Cash Cycle models and infrastructure including hardware and software innovation.

4.5 Opposition to Cash Cycle change

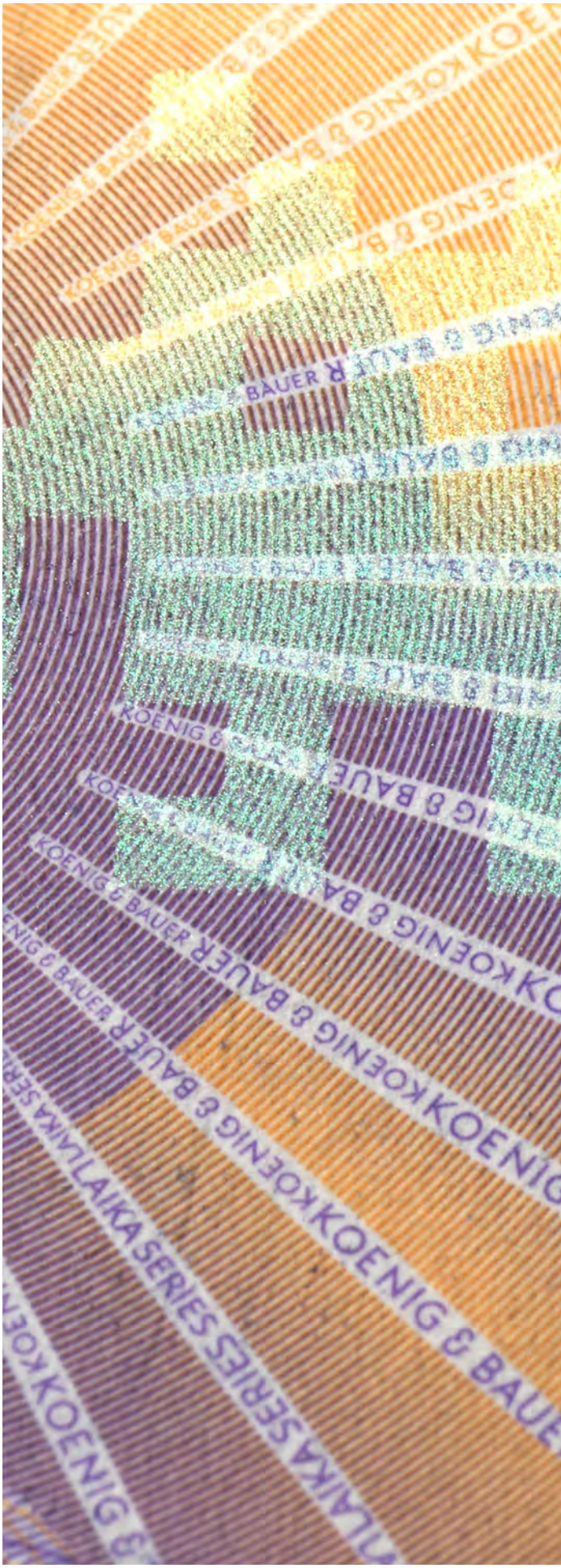
Opponents to and critics of cash cycle change may suggest that a more efficient banknote service system may have a downward impact on the volume of banknotes in circulation and that it is not really necessary. A more efficient, retail-layer Cash Cycle will increase the velocity of banknotes in circulation as they spend more time in an active transaction environment, being exchanged rather than in transit between access points and cash centers. Consequently, banknotes will become a more competitive and cost-effective means of making and receiving payment for all actors, driving a more sustainable form of demand that is based upon true user preference and choice rather than infrastructure inefficiencies.

The potential for a marginal and insignificant drop in banknote circulation volumes will be more than offset by the host of collateral benefits afforded to the public by cash innovation initiatives that will in fact, directly increase demand for banknotes in the following ways:

- Significant increase in cash access points and cash availability.
- Increase in banknote acceptance levels as cash becomes an integral component of a retailer's business and revenue model.
- New cash functionalities, use cases and market spaces.
- Reduced cash outages and need for emergency deliveries thanks to real-time data availability on the demand and supply side.
- Increased use of cash as new Cash Cycle models to create a more equitable spread of the cost of cash, making it more attractive as a payment tool for merchants, commercial banks and retailers.

All of the above factors will fuel a market-driven demand for banknotes (as opposed to an infrastructure-imposed level of demand) in excess of the nominal potential decrease in circulation volumes generated by a more efficient Cash Cycle. It should also be noted that a direct correlation exists between providing improved access to cash and increased usage of cash by the public and no evidence at all exists to demonstrate that maintaining or increasing the volume of cash in circulation will have any impact on driving demand for cash.

In simple terms it is all about supply and demand. By improving the cash service system and the value that cash can bring to the actors involved in making it available, using it and accepting it, demand will grow organically, creating a natural and sustainable point of equilibrium between supply and demand.



4.6 Key Take-Aways

Section 5: Data, the missing link

It is possible to exploit data from the Cash Cycle to significantly improve how cash is managed in society. In so doing, the cash community can develop a better picture of where cash is, who has it, who needs it, how much and optimise the ways of balancing demand with supply. Data may also become a facilitator of regulation change by Central Banks, enabling cash recycling activity by the retailer and effectively keeping cash where it is needed most; at the public/retail layer.

The key to making this possible is data and in particular, connecting the physical banknote with digital data ecosystems using 'bridging technologies'. Once data becomes available and is shared via a cash utility platform, the fragmented cash management industry will have the opportunity to pool resources to optimise their activity. A community-wide approach is required for success due to the scale and scope of the challenges involved but if the community can work together and adapt their business models accordingly, data may just be the missing link to significant positive change in the way we organise and manage cash in society. This section of the whitepaper explores how data plays a a pivotal role in Cash Cycle transformation.

5.0. The role of Koenig & Bauer Banknote Solutions in defining the future of cash

We recognise that the global cash community is working hard to address the cost and ecological impact of cash in order to make it a viable and sustainable payment tool in the highly competitive payment tool marketplace. We want to be part of this process and we see our role as a supporter and an enabler of Cash Cycle transformation by providing technology that connects the physical banknote product with digital data ecosystems.

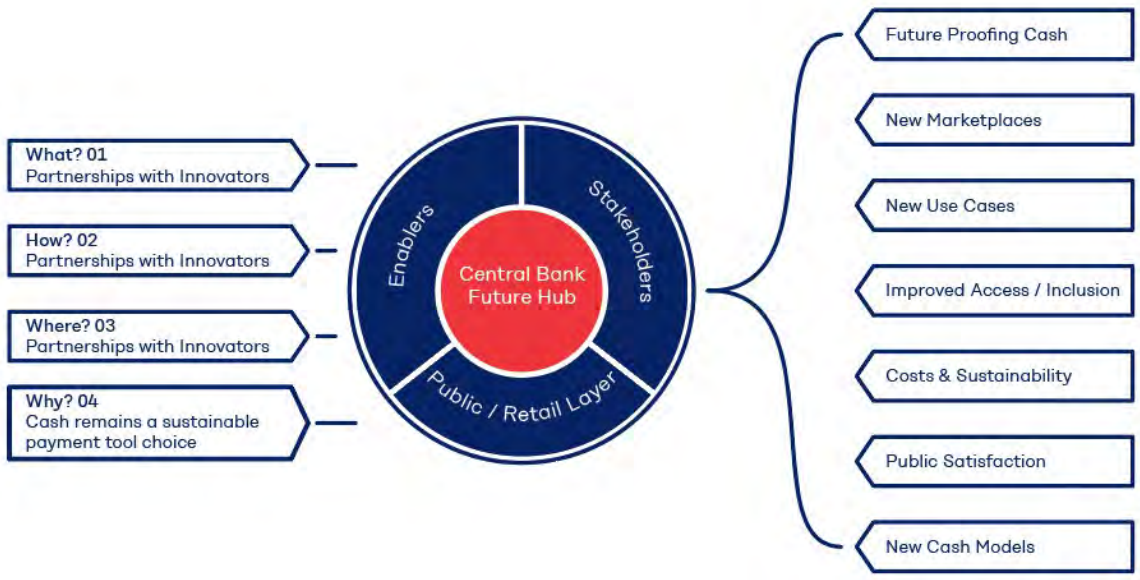
In so doing, new and existing actors can develop data-driven Cash Cycle models and services that were previously considered impossible due to an absence of access to reliable real-time data on how cash is moving in society.

By providing the 'missing link' that connects the physical banknote with data ecosystems, the global cash community can imagine and realise a different future by simply having a better picture of where cash is society and the best way to move it from those who have it to those who need it. By providing the 'missing link' to existing and new innovators, established processes and their inherent friction can be dismantled and replaced with more local cash organisation at a decentralised retail/user community level.

5.1. Bridging technologies

Central Banks will have an important role to play in this process. Our bridging technology will enable regulatory change, absolutely necessary to facilitate the development of community Cash Cycle models since it incorporates state-of-the-art integrated authentication and forensic functionality. By removing the current need to authenticate and process banknotes at a centralised level the traditional role of cash centres will become democratised at community level reducing/removing friction sources associated with CIT activity.

The democratisation of cash management will also revolutionise cash access using cash-in-store and other emerging models, significantly reducing the costs and ecological footprint associated with ATM operations. It will also allow ATMs to become greener and more sustainable via self-fill and locally sourced replenishment banknotes.



Since existing Cash Cycle models have been built upon the business models of actors such as cash management companies and commercial banks, our 'bridging technology' must provide value and opportunities for them. It will empower these actors to develop new business models around how to exploit the connected community Cash Cycle and invent a new range of data-driven services and products.

The ultimate culmination of innovation using 'bridging technologies' will be the creation of local, regional and even national cash management utilities or CashGrid networks which digitally monitor in real-time physical banknote movement, inventories, demand & supply points, enabling smart and sustainable cash management.

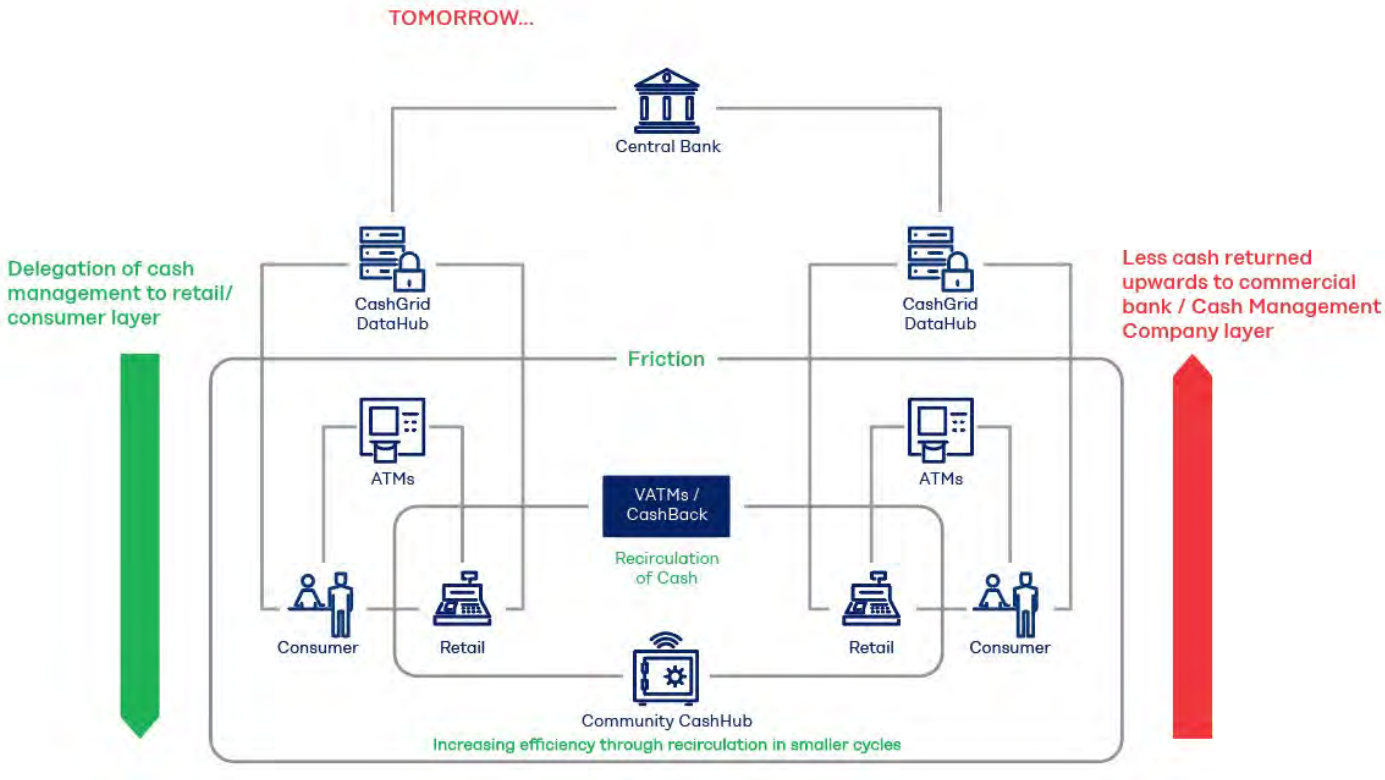
Data and access to this data will be the key to future cash sustainability. By providing structured layers of data to a hierarchy of data consumers involved in cash management, on-demand services can be replaced with smart predictive services automatically calculating the most efficient way to move cash from point A to point B and triggering the appropriate mechanisms to make this happen.

From a banknote user perspective, our technology will allow Central Banks to work closely with innovators to create new banknote value propositions, use cases and enter new marketspaces. On-line payments and transfers such as remittance payments with cash will become possible thanks to a new level of connectivity.

New layers of functionality will also be added to banknotes as their role and potential expand to meet changing user expectations. Some of these possibilities are listed in the table below.

Max Levchin, PayPal co-founder once said; 'data makes everything possible'. We believe this is true. The Cash Cycle models of the future we describe above are not simply dreams. They will become a reality and create significant business opportunities for new and existing actors to transform how we move cash in society today into a smart, sustainable and equitable model.

The one common denominator required to do this is to provide a secure, robust, proven, trusted, easy to use and scalable technology that will allow a banknote connect to the digital world. While this will enable banknotes to enter some new market spaces and enjoy new use cases, the primary focus of our research has been to use our bridging technologies to radically transform the way Cash Cycle stakeholders think about cash and how we manage it in society.

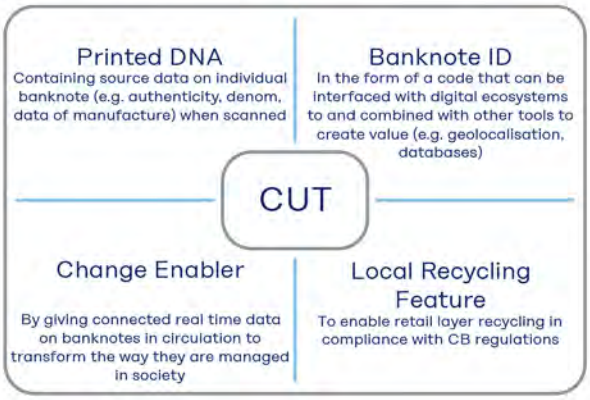


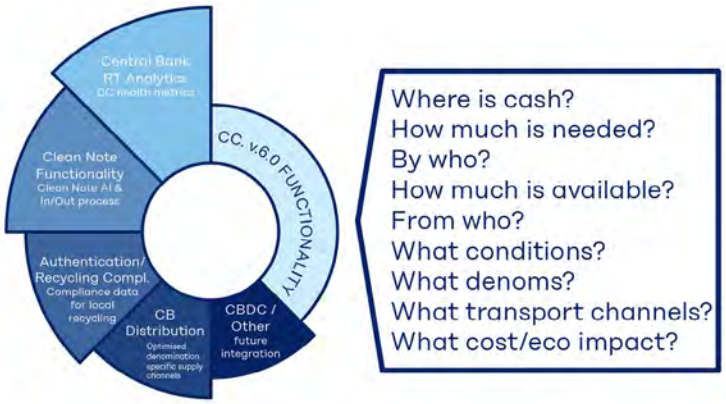
5.2. Data as an enabler of change – introducing CUT®:

Our approach has not been to create end-to-end solutions but to fill the gaps that exist in the banknote service system and enable change by providing the tools and technology necessary to connect the banknote to digital ecosystems, thereby enabling innovators to do the rest. To date most of the innovation in this space has been achieved without the direct involvement of banknote designers and printers.

Just imagine what is possible when we break down this mindset and use upstream processes such as design and printing to enable quantum innovation and evolution by stakeholders right through the cash access, movement and use stream.

This is what our Cash Utility Technology (CUT®) is all about. Using state of the art design and printing to provide innovators and game-changers the tools necessary to build new banknote service system models and at the same time develop new and exciting business models to support the future demand for and sustainability of cash.





5.3. What is missing – The critical link?

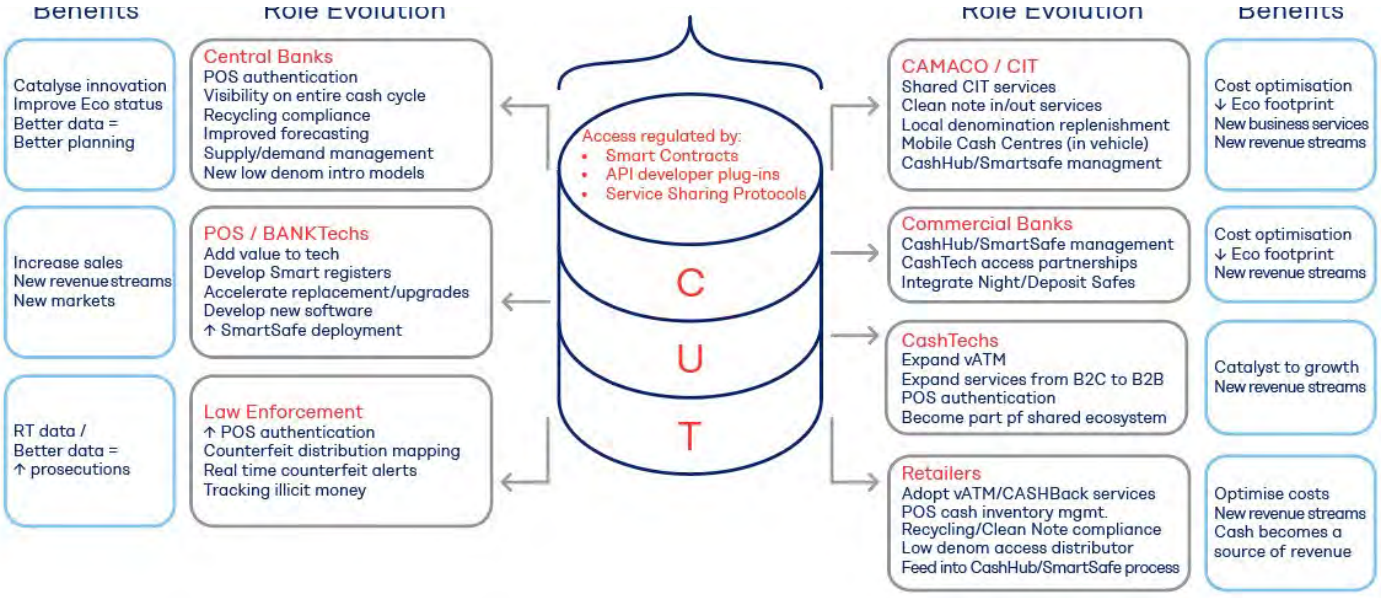
By connecting the physical banknote to digital ecosystems, we can make highly-specific data layers available to data clients who are all working to make cash more sustainable.

5.4. Data clients & benefits:

Secure access to a hierarch of functional and analytical data will enable stakeholders and active participants to optimise cash movement and access according to real-time aggregate (statistically significant) and raw data from the Cash Cycle. It will ensure compliance with recycling regulations and provide a platform for continuous improvement by innovators in terms of how cash is accessed, moved and used.

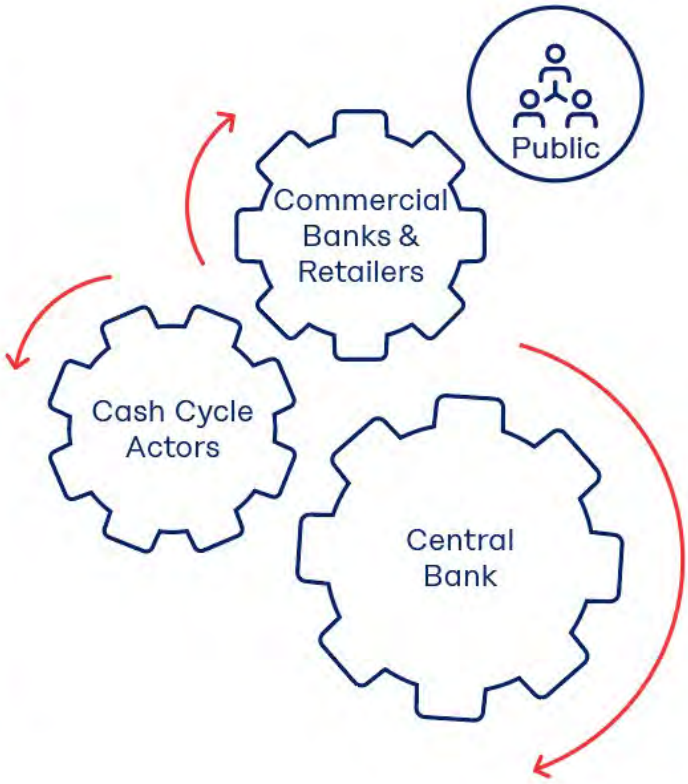
Examples of the tangible benefits accrued from connecting to a CashGrid hub include the following:

- Compliance with Central Bank recycling regulations
- Cost reductions
- Efficiency improvements
- Reduced ecological footprint
- Visibility on banknote loads, inventory and flows within local and regional cash cycles
- Predictive and on-demand matching of banknote supply and demand
- Optimised banknote transportation routes
- Introduction of new banknote access and recycling models
- Catalyst to develop new business models by existing cash community actors
- Enabler of disruptive technology/process introduction



CUT® is a **shared and equitable** cash community investment with a quantum return for **all**

- **Central Bank**
  Invests in building blocks and makes them available to the cash community
- **Cash Cycle Actors**
  Exploit CUT® to develop more efficient cash management processes and more sustainable business models
- **Commercial Banks & Retailers**
  Enjoy a lower cost/eco footprint of cash and promote cash access/acceptance
- **The Public**
  Continue to enjoy the convenience of cash access and acceptance and cash remains a sustainable payment choice



5.5. How does CUT® work?

CUT® technology is based upon the unique banknote DNA that is created during the printing process. Just like us, every banknote is different and our technology allows us to exploit these genetic markers to tell us a lot about the banknote including:

- What denomination is it?
- Is it genuine?
- When/where was it produced/issued?
- How long has it been in circulation?
- Is it fit for recirculation?

CUT® data can be quickly and easily captured at key touchpoints within the Cash Cycle such as:

- Mobile Device Apps
- Retail POS
- Banknote deposit terminals
- Cashback & cash-in-store outlets

By combining this data with geolocalisation and other inventory functionalities we can build up a complete picture of the status and health of banknotes circulating in a community. CUT® data will exploit existing data connections that exist within the Cash Cycle and allow the creation of local, regional and national cash monitoring infrastructures.

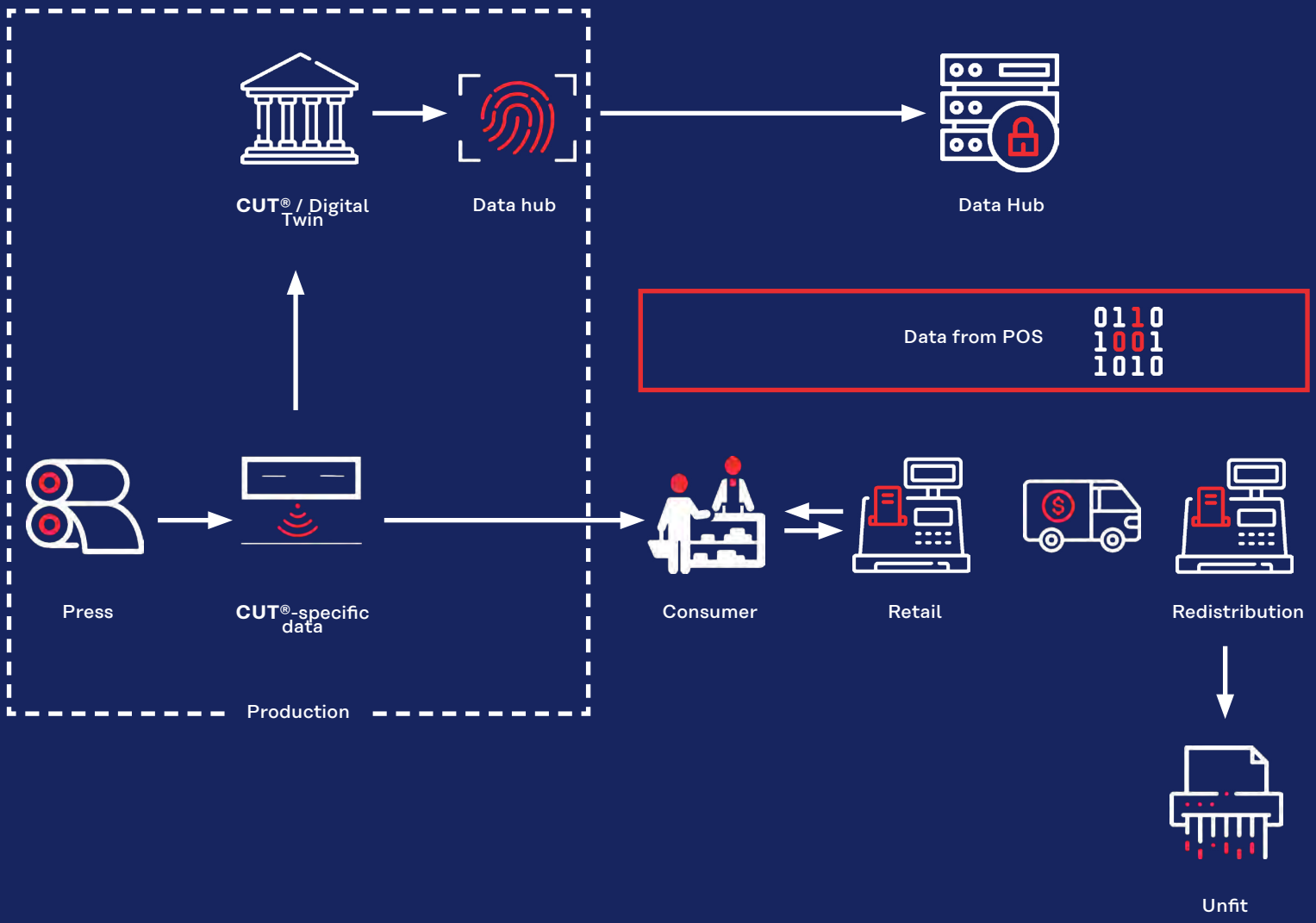
5.6. How is CUT® data created and used?

Every banknote in circulation around the world today already incorporates CUT®. Since CUT® is inextricably attached to the banknote DNA, there is absolutely no need to develop a new banknote series to benefit from it.

We are also developing a nextgen form of CUT® that will be activated during the banknote printing process where discrete integrated scanners harvest genetic data from the banknote related to its unique and individual print structures. This data is then used to create a digital twin of the banknote DNA model.

The beauty of CUT® is that it the banknote product requires no additional printing processes or security features to benefit from this innovation. No additional cash cycle data infrastructures are required by stakeholders such as retailers and only minor upgrades are required by automated payment terminal operators. The creation of local or community CashGrids will ultimately lead to the creation of interconnected CashGrids feeding into one central national utility where national data can be centralised and processed for other purposes.

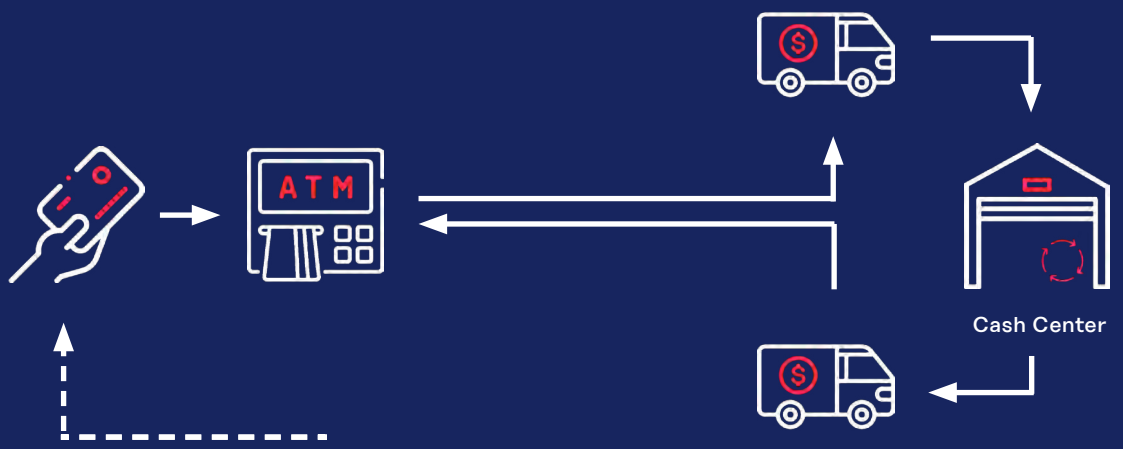
5.7. CUT® use case scenarios:
The following typical examples of how cash currently moves in society compared with how it could be managed in the future serve to illustrate how CUT® can be leveraged to enable significant change and deliver significant improvements by removing friction and reducing the associated cost and ecological impact generated by these friction processes.



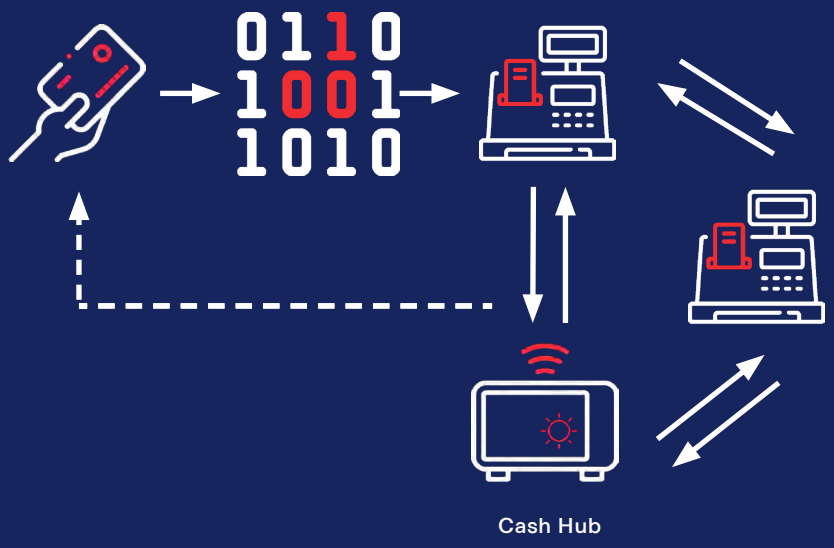
Cash access (ATM):

Current ATM cash access model

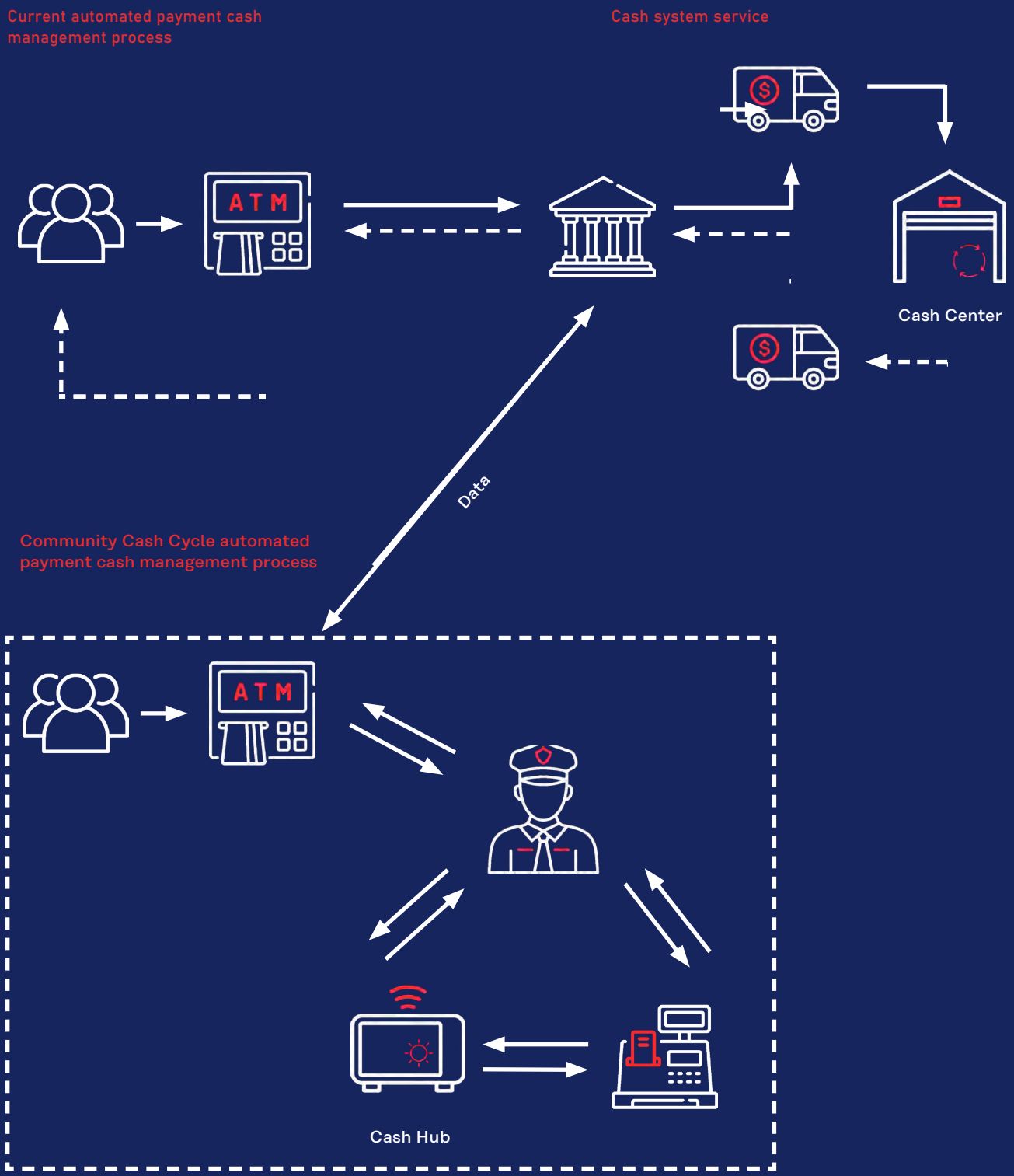
Cash system service



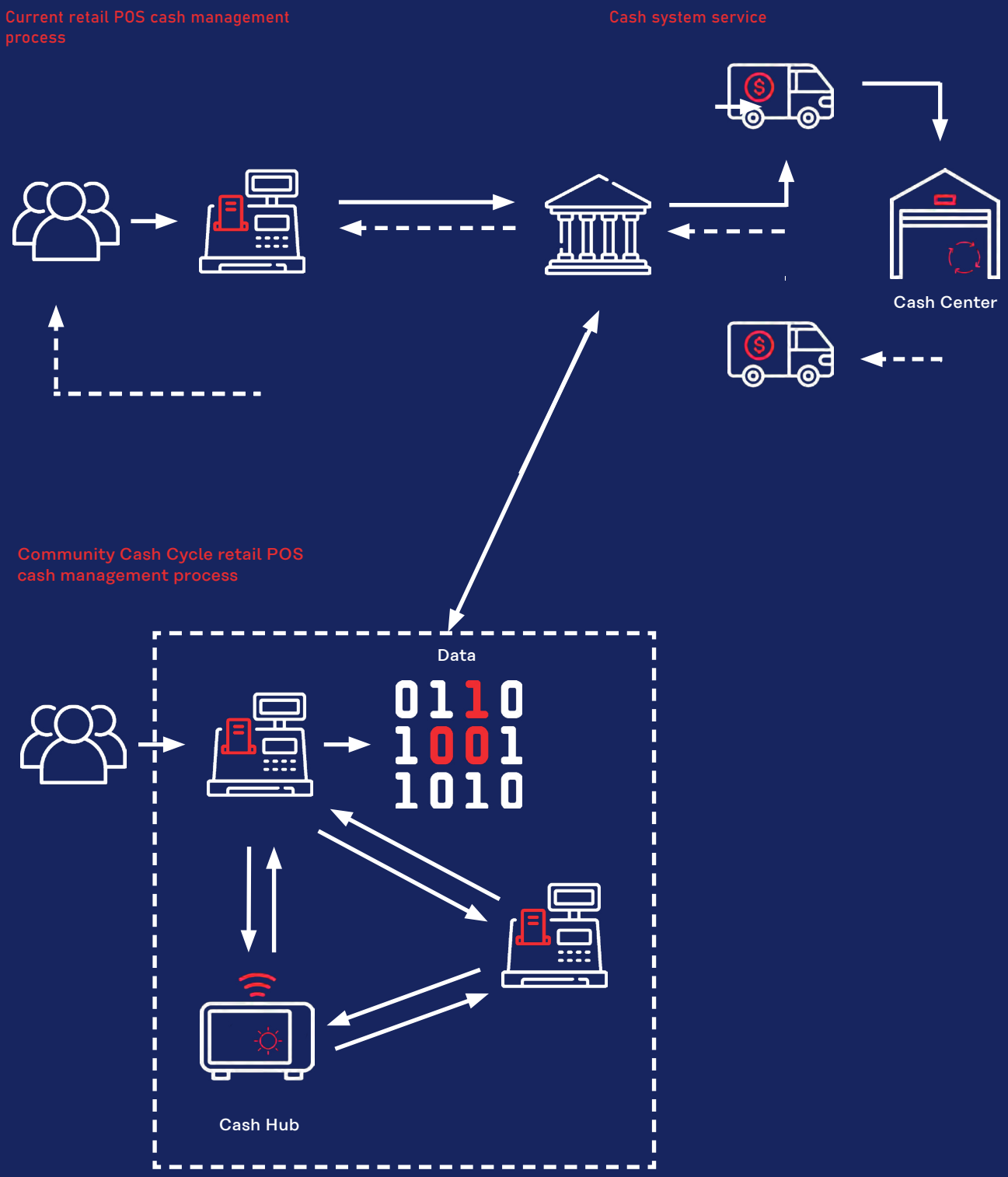
VATM/cash back cash access model



Automated payment terminal cash management:



Retail POS cash management:



5.8 Key Take-Aways

Section 6: A blueprint for the future

It is difficult to describe in precise terms what the banknote service system of the future will look like. The future provides us with no data nor concrete examples to draw reference from. It is up to us to create this future and our capacity to adapt and drive change will define the position of cash in the global multi-payment tool marketplace.

This whitepaper is a call to action for anyone interested or involved in how cash acts as an essential component of human, social and commercial exchange. While we may not know exactly what the future will look like, we do know that creating it will involve a level of community-wide collaboration on an unprecedented scale. Silos must be dismantled, logical concessions made, partnerships developed and new business models created. But this is the stuff evolution is made out of and it represents an exciting opportunity to write a new chapter in cash evolution, based upon solid fundamentals of a win-win relationship with cash for all Cash Cycle stakeholders.

We invite you to become part of this movement and join us as we bring the wider cash community together in a conversation that will have a significant impact on all of us.

6.0. Using the product to solve the support system problems

Future Cash Cycle models will be built upon data from the physical world but channeled and analysed in the digital world. Our community needs a family of technologies to allow us create this connection between the physical and digital world of banknotes and their ecosystem.

Our CUT® is based upon actual banknote DNA and does not require a new series design to become functional. Any Central Bank in any country around the world can immediately begin leveraging the power of our CUT® technologies that are based upon the DNA of all banknotes currently in circulation to capture valuable utility information and begin transforming their Cash Cycle models.

Period	Trigger	Description	Level of automation	Level of friction	Cash distribution path
1900's – 1960's	GDP/population growth	Simple 2-way cash	OOOOO	OOOOO	Central Bank to Commercial Bank
1960's – 1980's	ATMs	ATM enabling	●OOOO	●OOOO	Central Bank to Commercial Bank to ATM
1990 – 2000	High speed sorting	Centralisition of recycling	●●OOO	●●OOO	Central Bank to cash center to Commercial Bank to ATM
2000 – 2010	Denomination specific Distribution channels	Utilisation of retail layer	●●●OO	●●●OO	Low-retail/Mid-ATM/ high Commercial Bank
2010 – 2020	Profileration of clean note policies	↑ Demand of integrated cash management services	●●●●O	●●●●O	Cash management Company controlled
2020 – Today	Cost/ecology/access/ acceptance	Brink of major change	●●●●●	●●●●●	Retail layer recycling
2023 – The Future	Data	Retail layer cash management	●●OOO	●OOOO	Retail layer supported by smart cash management

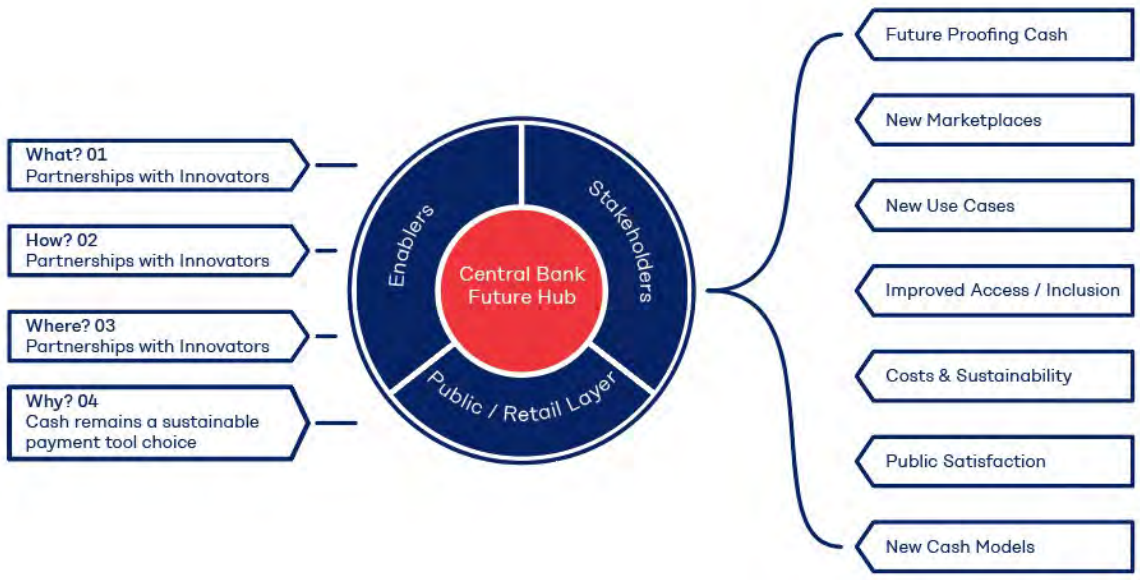
6.1. Roadmap – How will we get there?

- Collaboration and beginning the conversation.
- Enable Central Bank initiated banknote recy cling legislation change.
- Enable Central Banks to deploy new value-add ed use cases for cash to be realised by innova tors.
- Provide Central Bank's with improved RT data to monitor CIC against key metrics.
- Enable RT alerts/hotspot/red flag and other and criminal activity detection.
- Ensure improved access and continuity of sup ply via new access models (CashBack/VATM).
- Create new business opportunities for cash management companies by changing business model & services around CasHub & CashGrid .
- Create new business opportunities for BankTech by providing new technologies to create Cash Hubs.
- Allow Commercial Banks return to a profitable cash management service.
- Improve retailer cash product service range/ revenue.
- Support CashTechs to develop their business and significantly increase/accelerate onboarding of retailers and the public.
- Encourage retailers to view cash services as a revenue opportunity and not a cost by offering clearly defined cash services access/deposit/ recycling).
- Reduce retailer cost of cash.
- Provide toolkit to CashTechs to pursue business goals while improving cash sustainability.
- Provide the public with a more sustainable and greener way to access, spend and store cash.

6.2. Our vision of the future:

While the landscape is not complete yet, we believe that CUT® will help actors fill the gaps and make the required change possible.

In summary, our vision of the future of cash is built on the following actions and actor involvement.



6.3. Final thoughts

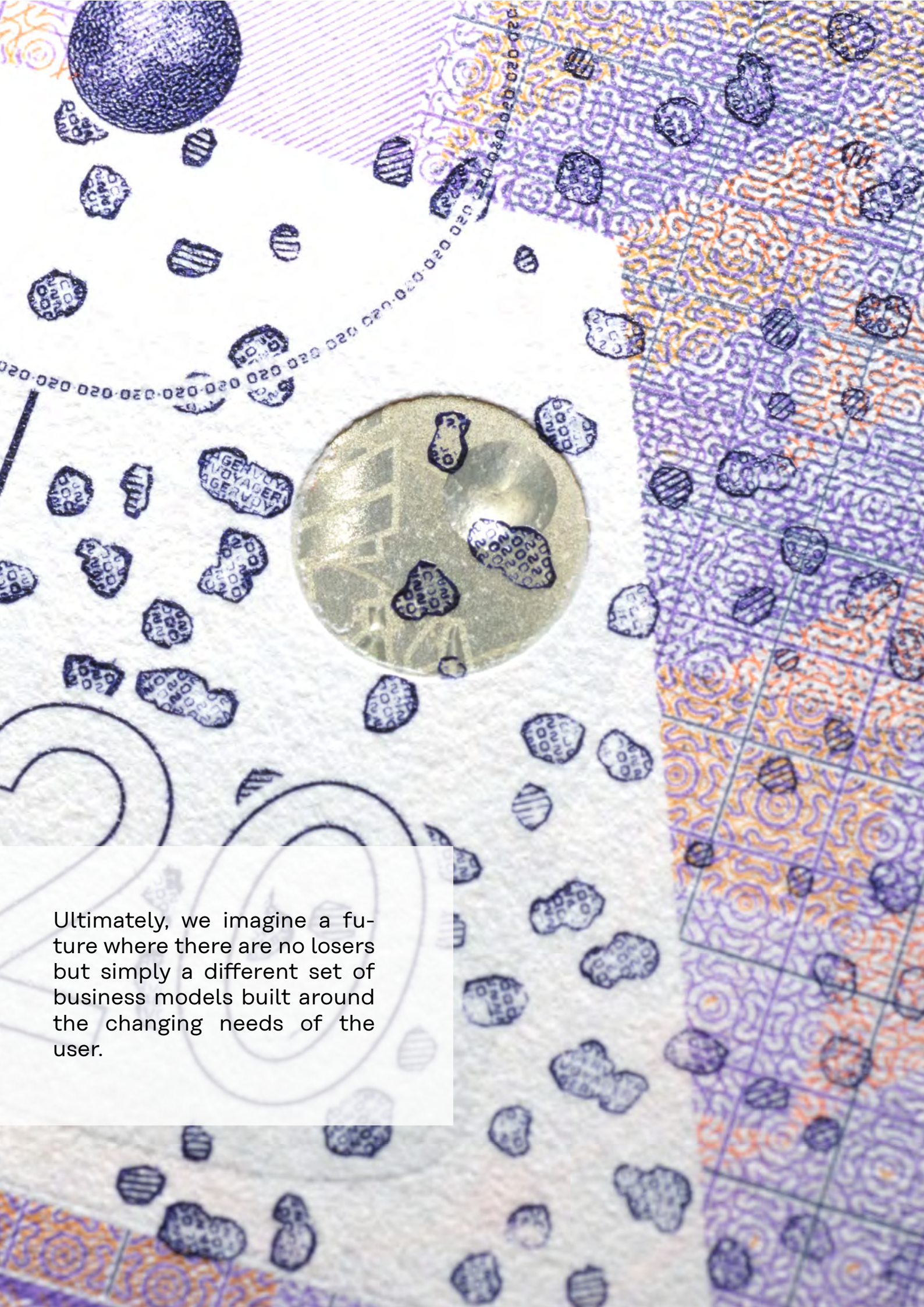
This whitepaper is the beginning of a conversation, a conversation that will include more actors than ever before. Fixing the banknote product service system requires a cross-community effort. We must break down the silos we operate in and embrace a wider family of actors to find innovative solutions.

A great deal of innovation is already taking place in terms of improving how banknotes are moved, used and accessed. Much of this innovation is straight forward and incredibly simple such as Cashback, VATMs, local recycling models and enabling technologies, etc.

To date this innovation has largely taken place without involving our industry – the banknote design/ production people.

To put it simply we cannot fix the product service without considering and adapting the product. The product itself can become an enabler of innovation and as we drive innovation to include all actors, we open new opportunities. New processes and technologies will emerge to make cash more sustainable. Some of this will be disruptive and some, simple common sense. But as we improve the way cash is moved, accessed and used, we will begin a new journey towards a more sustainable future for cash.

We invite you to join us on this journey. To find our more, please visit https://banknote-solutions.koenig-bauer.com/en/digital/



Ultimately, we imagine a future where there are no losers but simply a different set of business models built around the changing needs of the user.

The global cash community must break down silos and come together in the conversation around cash evolution.

The scale and scope of what needs to be done precludes any one industry sector or organisation to solve the problem on their own.

6.4 Key Take-aways – Only one: Cross-community collaboration

We will provide a new platform and technologies to enable Cash Cycle actors explore, exchange and discover what is possible when a cross-community initiative is ignited. We aim to provide some of the building blocks for the Cash Cycle of the future and to support a new and more sustainable approach to how we organise and manage cash in society.

Now it is up to you and your organisation to join the cash innovation movement and to play an active role in the change process. We want to be part of this process, not simply as a technology toolbox provider but most importantly, as a platform to bring the global cash community together.

This whitepaper represents a sharing of ideas and thoughts and the beginning of a process that depends upon your participation to achieve meaningful positive change.

We will provide a new platform and technologies to enable Cash Cycle actors explore, exchange and discover what is possible when a cross-community initiative is ignited.

Now it is up to you and your organisation to join the cash innovation movement and to play an active role in the change process. We want to be part of this process, not simply as a technology toolbox provider but most importantly, as a platform to bring the global cash community together.

Our next step is to organise a series of Cash Innovation Future Thinking Labs in 2023 to connect our community around this subject and facilitate an ongoing dialogue. While many of us may be joining this conversation from different starting points, community viewpoints or industry sectors, we must align ourselves to a common vision of the future.

Our Cash Innovation Future Thinking Labs are designed to allow us reach this point and then fill in the gaps by defining our individual and collective roles to make the vision become a reality.

Follow us on LinkedIn to get regular updates on how we are working to enable change in the global cash community and please send us your feedback on this whitepaper to cash-innovation-bns@koenig-bauer.com

6.5 Who is Koenig & Bauer Banknote Solutions?

Koenig & Bauer Banknote Solutions SA is the global leader in banknote design and production technology. We believe in the freedom and independence cash brings to everybody, anytime, everywhere. To keep cash universally accessible, we act as the key partner that drives innovative banknote production technologies and services.

We recognise that banknote design and production represent only one part of a far bigger picture concerning how banknotes are accessed, moved and used. However, these critical upstream processes can have a powerful and enabling impact on how Cash Cycle models can be innovated and changed to reduce costs and ecological impact, ultimately making banknotes a highly sustainable and competitive payment tool.

Our success has been built on partnership and industry engagement. By listening to our clients and fostering a spirit of future thinking among our employees and partners, we have greatly contributed to making banknotes the best they can be while meeting the rapidly changing user expectations.

Today we go even further, by building a bridge between the banknote product and the banknote product service system. By connecting the physical banknote product to digital data ecosystems, industry actors and newcomers can revolutionise the way cash is organised and managed in society.

Our mission is to support cash sustainability through innovation and partnership. Our inspiration and motivations to develop this whitepaper are born out of a sincere wish to bring the global cash community together around the subject of the future of cash and how we can significantly improve the way it is distributed and accessed. Our tomorrow may not be built upon the way we did things in the past but it will depend on how we act today....

Join us in the cash sustainability conversation and make your voice heard!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