It is Along Ways

Global Payment Infrastructure in Movement

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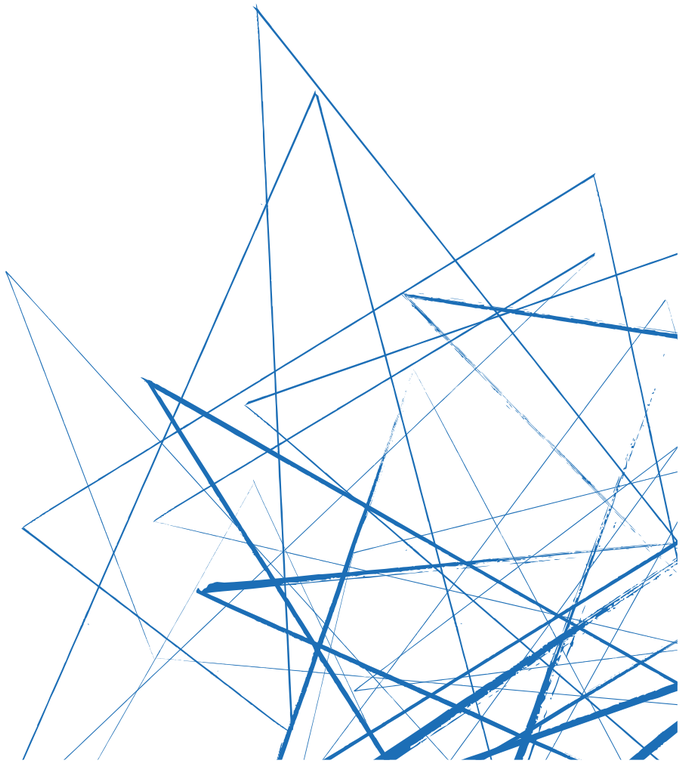
IT IS ALONG WAYS – GLOBAL PAYMENT INFRASTRUCTURE IN MOVEMENT



PhD Series 28.2023

Juan Camilo Giraldo-Mora

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GLOBAL PAYMENT INFRASTRUCTURE IN MOVEMENT

Department of Digitalization | **PhD Series 28.2023**

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Global Payment Infrastructure in Movement

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This work reveals movement in infrastructure development through an anomaly in the global payment infrastructure. The anomaly is that while the global payment infrastructure develops without precedent, the infrastructure takes time to develop and does not easily leave anything behind. Based on abduction, the research builds a data corpus of past, present, and future global payment infrastructure, 1973–2030, including accounts of global payment organisations, historical reports, and narrative interviews. By juxtaposing these data with studies on infrastructure and following the work of Heidegger and Bateson, the research reveals movement through what the author terms infrastructural *ways*.

The global payment infrastructure forms and develops because there are infrastructural ways for global payment to be objects, pass as real, and result from action. Granular homogenisation, irreversible validation, and ubiquitous causation are such ways. Moving *along*, hurtling, swaying, and rippling are the infrastructural ways for global payment to be objects passing as real, pass as real with action, and result from active objects. These findings clarify through movement how the global payment infrastructure develops. In doing so, this work contributes an ontological approach that revisits the predominant assumptions about infrastructure development, which emphasise the persistence and change of infrastructure.

Abstract in Danish: Denne afhandling undersøger bevægelser i infrastrukturudvikling gennem et studie af en anomali i den globale betalingsinfrastruktur. Anomalien består i at den globale betalingsinfrastruktur udvikler sig uden fortilfælde, samtidig tager infrastrukturen tid at udvikle uden at efterlade noget tilbage. Baseret på princippet om abduktion opbygger afhandlingen et datakorpus af global betalingsinfrastrukturs fortid, nutid og fremtid for perioden 1973-2030. Dette datakorpus består af beretninger om globale betalingsorganisationer, historiske rapporter og narrative interviews. Ved at sammenstille disse data med undersøgelser af infrastrukturudvikling og følge Heideggers og Batesons værker, afslører forskningen bevægelse, også betegnet af forfatteren som infrastrukturelle veje.

Den globale betalingsinfrastruktur dannes og udvikles, fordi der er infrastrukturelle måder, hvorpå global betaling kan være objekter, fremstå som reelle og resultere i handling. Granulær homogenisering, irreversibel validering og allestedsnærværende årsagssammenhæng er sådanne måder. Bevæge sig langs, susende, svajende og krusende er de infrastrukturelle måder, hvorpå global betalinger kan være objekter, der passerer som virkelige, passerer som virkelige med handling og resulterer fra aktive objekter. Resultaterne tydeliggør, gennem bevægelse, hvordan den globale betalingsinfrastruktur udvikles. Afhandlingen bidrager hermed med en ontologisk tilgang, der genbesøger de dominerende antagelser om infrastrukturudvikling, hvilket understreger infrastrukturens vedholdenhed og forandring.

Contents

Preface

Luck is difficult to explain, and so is where this work begins and ends. Indeed, this thesis is a puzzle I am still working to solve. The intellectual quest spanning from the London School of Economics and Political Science to Copenhagen Business School has taken me to Denmark, Colombia, the United Kingdom, and Italy. I never thought of studying at these prestigious institutions, traversing these great countries, conversing with exceptional scholars, or meeting such wonderful people. The good luck behind my journey makes it challenging to explain the background of this study. Nonetheless, I can think of three memorable experiences that side with the uncertainty that welcomes luck.

The first memorable experience was my first day working at a company that offers global payment services in London, a city of immigrants, more than thirteen years ago. A physically large person from Nigeria was my first client. He shouted, “Where is my money?!” and a colleague from Africa calmly took over. Meanwhile, at the next counter, another colleague from Ecuador was handling a queue of ten people and helping a customer “walk around” a regulatory requirement to transfer money to her grandson. After about fifteen minutes, we had solved all the clients’ issues, and our Nigerian client left exclaiming, “God bless you!” Seeing my colleagues adjusting and improvising to serve others spurred me not only to consider how important small acts are but also to dedicate myself to understanding and changing what lies behind the transfer of money across countries. After all, the global payment infrastructure was being otherwise.

The second memorable experience occurred during my first semester as a master’s student at the London School of Economics and Political Science. I approached a professor after his lecture on infrastructure. I asked for his thoughts about writing a critical literature review on blockchain, a new topic and technology I had followed for some years. He said something like, “Of course! What’s interesting about blockchain is that it is highly centralised and decentralised.” This description sparked my curiosity, and I dove deep into infrastructure literature and questioned popular assumptions about technology. I contemplated whether technology could be defined through artefacts, in isolation, or in situ.

The last memorable experience occurred at a cafe in Frederiksberg, near Copenhagen Business School. I was waiting for a call from my supervisors. We were going to decide how to continue and finish this thesis. Despite having only a few months of funding left, I did not suggest wrapping things up but instead diving into Martin Heidegger's and Gregory Bateson's works. Both wise and resigned to my stubbornness, they said something like, "Do whatever you want, but go all in." While deeply rooted in their works, this thesis is neither Heideggerian nor Batesonian. It is not pure, per se. Instead, this work goes all in on exploring, on abandoning the safe bounds these two inspiring scholars developed.

These three experiences side with uncertainty in the sense that they welcome the unexpected. However, saying this work embodies a eureka moment would be an overstatement. Rather, this study questions and explores the bounds of infrastructure literature and its philosophical assumptions by examining the development of global payment infrastructure. Like luck, this work inhabits uncertainty. The study moves away from any safe transcendence and gives primacy to movement over relationships and processes.

While I remain responsible for my choices, stances, and arguments for and in this thesis, many people were part of its quest. I sincerely thank my supervisors, Jonas Hedman and Michel Avital, for expressing their curiosity, sharing their academic enthusiasm, and supporting me and my project unwaveringly and patiently. This thesis developed through supervision meetings that have yet to yield an agreement. When our meetings converged, it was out of curiosity and necessity. Jonas' line-by-line comments and thoughtful suggestions always arrived when I most needed them and helped me to keep going. Michel's standards and incisive arguments ensured this thesis went further than it would have otherwise.

The assessment committee, Jacob Nørbjerg, Nancy L. Russo, and Jonny Holmström, offered thorough reports that were as insightful as they were instrumental to improving the thesis' clarity and cohesion. Carsten Sørensen, Attila Márton, Xiao Xiao, Philipp Hukal, Stefan Henningsson, Jan Mouritsen, Till Winkler, Jan Damsgaard, and Helle Zinner Henriksen are among the scholars and colleagues who fuelled my intellectual curiosity, offered teaching opportunities, or provided the support I needed to continue this study. Further afield, a conversation with Susan Scott and the works of Chrisanthi Avgerou and Jannis Kallinikos also provided intellectual inspiration during my initial explorations. Chats with, among others, Nicola, Philipp, Paul, Francesco, Ignacio, Tawfiq, Lucas, Nina, Katrine, Stig, Ruben, Carlos, Niño, Parrita, and the PhD community at Digi were invaluable, day-to-day fun. Bodil, Cecilie, and the

rest of the secretariat at Digi and the PhD School offered kind and professional assistance throughout the past six years. The wise and generous interviewees as well as the lengthy discussions with Veronica Studsgaard and her support in contacting interviewees motivated and insightfully shaped this work. Uncle Oscar, father Miguel, mother Sandra, brother Santiago, the memory of grandfather Miguel Giraldo, my family at large, and life partner Elena were always there as I navigated the valuable difficulties of leaping toward uncertainty. Many are part of this thesis, which, like any other, is an experience beyond one scholar. To all with whom I had the luck of sharing a walk and a talk, thank you.

As a last note, I would like to clarify the presentation of this study. Rather than offering a complete knowledge object like papers typically do, this monograph strives for a starting line of exploration. Thus, the presentation of the thesis resembles a metalogue,[1] where structure is content and the content lies beyond any textual description or definition. This means the thesis argument develops cumulatively, ongoingly, and without a definite end, as follows.

[1] Bateson (1972, p. 1) defines a metalogue as a "conversation about some problematic subject" where "the structure of the conversation as a whole is also relevant to the same subject."

CHAPTER ONE

The Necessity of Revealing Movement in Infrastructure Development

What doesn't let you sleep at night?

Oh, I always sleep… [long silence]

Well, I think… [long silence]

Well, first of all, it is bringing all of a sudden… [long silence]

So, you have the standard ISO20022, you have the introduction of instant payments, you have new systems addressing global retail payments that were hardly existing a couple of decades ago. All of that seems to come together in a period of three, four, five years now. Popping up as a new requirement in payments. And what I find challenging and intriguing is that payments have been so stable. For 25 years hardly anything moved. A payment in 1990 was exactly the same as a payment in 2008. The formats were usually the same, the way it was done was the same, the speed at which it was done was the same. It was covering the same kind of underlying products. There was no movement in payments; a payment was a payment. And now, all of a sudden, these payments need to become 150 times as fast, they are not domestically focused anymore because all of a sudden people in the street are starting to do global payments, which, why would you do that 20 years ago. So, you're getting global payments for retail for very very small transactions on a very 24/7 basis. All those challenges together make the payments market with the ten-defender community around it, the software providers, and the discussions in domestic markets… [long silence].

It's becoming so living and so boiling all of a sudden, that yeah, you don't know where to look first.

— Interview with a senior executive

Infrastructure is hard to change. Thus, in our day-to-day experience, it often disappears and becomes invisible. Infrastructure is, in its nature, always ready and useful. Such is the case until there is change. When infrastructure changes, it becomes simultaneously less ready and more present. This is the case with any infrastructure and especially with the global payment infrastructure. However, the global payment infrastructure presents an anomaly. Even though it develops without precedent, this infrastructure does not happen de novo or in situ. In different words, while the global payment infrastructure no longer continues from a past infrastructure, it develops with time and without easily leaving something behind. Then, *how does the global payment infrastructure develop?*

In short, the answer to this question is movement. Before unfolding the inquiry, however, this introduction extends its practical, theoretical, and ethical relevance. The chapter proceeds with the anomaly of continuity in the global payment infrastructure, which further unfolds practical motivations. Then, the chapter introduces infrastructure studies and the theoretical and ethical importance of clarifying the development of the global payment infrastructure with movement. An outline of the inquiry closes this introduction.

The Anomaly of Continuity in Global Payment Infrastructure

The global payment infrastructure develops without precedent. At its most basic level, the infrastructure allows for the transfer of money (e.g., between payer and payee) across countries and currencies. As the global payment infrastructure involves different countries, currencies, organisations, and people (and, therefore, many payment relationships), everything moves. There are infrastructural breakdowns, which are experiences of change that alter our day-to-day existence (Star & Ruhleder, 1996). One example, which came as a reaction to Russia's invasion of Ukraine (European Commission, 2022), are the recent sanctions that excluded some Russian Banks from the global payment messaging network SWIFT.[2] Another example is when the United Kingdom's banks closed accounts for global payment providers servicing Somalia in 2014 (Banning-Lover, 2015).

Even though it is without precedent, the development of the global payment infrastructure takes time (Segendorf & Skingsley, 2022). In the early 1300s, the Medici Family established

[2] SWIFT stands for Society for Worldwide Interbank Financial Telecommunication.

payment instruments and ledgers that are still present in today's global payment infrastructure (de Roover, 1963; Ferguson, 2008). Similarly, recent developments with Blockchain technology and cryptocurrencies encompass a temporally long development that extends to the cryptographic advancements of Merkle Trees since 1979 (Merkle, 1979). Thus, the global payment infrastructure suggests an anomaly. Whereas its unprecedented development implies a discontinuous infrastructure, with frequent change, the temporally long development implies a continuity over time and accumulation in the global payment infrastructure.

Currently, understanding this infrastructural development matters. Simply put, the global payment infrastructure — and its potential breakdowns — are critical for society (Gomber et al., 2018; Scott et al., 2017). The largest source of foreign income in developing countries is through the global payment infrastructure, as Figure 1 illustrates (World Bank, 2019, 2021). Global payment involves human living and lives (Acosta, 2020; Banning-Lover, 2015; Scott & Zachariadis, 2012), and so its infrastructure matters both symbolically and materially (Barad, 2003; 2007). The development of global payment infrastructure implies "cutting lifelines" (Banning-Lover, 2015, p. 1) and creating[3] them (Acosta, 2020).

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[3] For example, there are various interests in reducing global payment costs following their statistically significant effects on inequality and poverty (Acosta, 2011; Acosta et al., 2008; Orozco, 2013; Orozco & Martin, 2022). Even though results vary, there is evidence from Latin American countries (Orozco, 2013; Orozco & Martin, 2022). There are estimations for extreme poverty to fall by 35 per cent in Mexico and El Salvador, and moderate poverty by 15 and 21 per cent, respectively, according to the United Nations poverty and extreme poverty thresholds. These percentages fall when accounting for the potential income migrants would make in their home countries (Acosta, 2011; Acosta et al., 2008). The average reduction of extreme poverty in Latin America falls from 14 to 3 per cent, and for moderate poverty from 8 to 3 per cent. In Mexico, El Salvador, Honduras, and Peru, poverty seem to increase. However, these latter estimates also background the potential professional growth in developed vis-à-vis developing regions (Acosta, 2011; Acosta et al., 2008).

In addition to its general association with poverty, global payment and its infrastructure are also associated with children school attendance, labour participation and distribution, financial inclusion, and terrorism. Evidence from El Salvador varies according to different demographic groups (Acosta, 2011). Young women between 10 and 18 years old seem to have a 10.9 per cent higher probability of staying in school than households not receiving global payment. Young men between 10 and 14 years old seem to work less for paid jobs, such as crop collection, and instead contribute non-paid work in their household. However, for young men between 15 and 18 years old, there seems to be a significant effect of global payment and school dropout, and these young adults seem to do unpaid work in their households (Acosta, 2011). Regarding labour participation, for household adults between 20 and 59, women also appear to reduce working hours in domestic activities (e.g., cooking, cleaning, childcare, etc.) by 3 hours a week from an average of 45 hours. At the same time, their likelihood of labour participation and working hours in farming activities increase by 6.8 and 10 per cent, which appears to be significant after considering that, on average, 34 per cent of women in rural areas in El Salvador engage in these activities (Acosta, 2020). Lastly, men appear to be more involved in domestic activities in households receiving global payment.

There are also indicators of global payment implications outside Latin America (Fajnzylber & López, 2008). For example, in the Philippines, positive shocks for individuals abroad appear to lead to higher income for receiving households, increasing children's school attendance and reducing their labour (Yang, 2008). In Nigeria, increasing global payment income is associated with asset accumulation among families (Ajefu, 2018). In Kenya, with the use of mobile phones and the development of global mobile payment services, global payment is associated with financial inclusion due to a large number of mobile phone users compared to those with access to traditional financial services (54 per cent of the population against 19 per cent at the time of the research) (Mirabaud, 2009). With mixed findings,

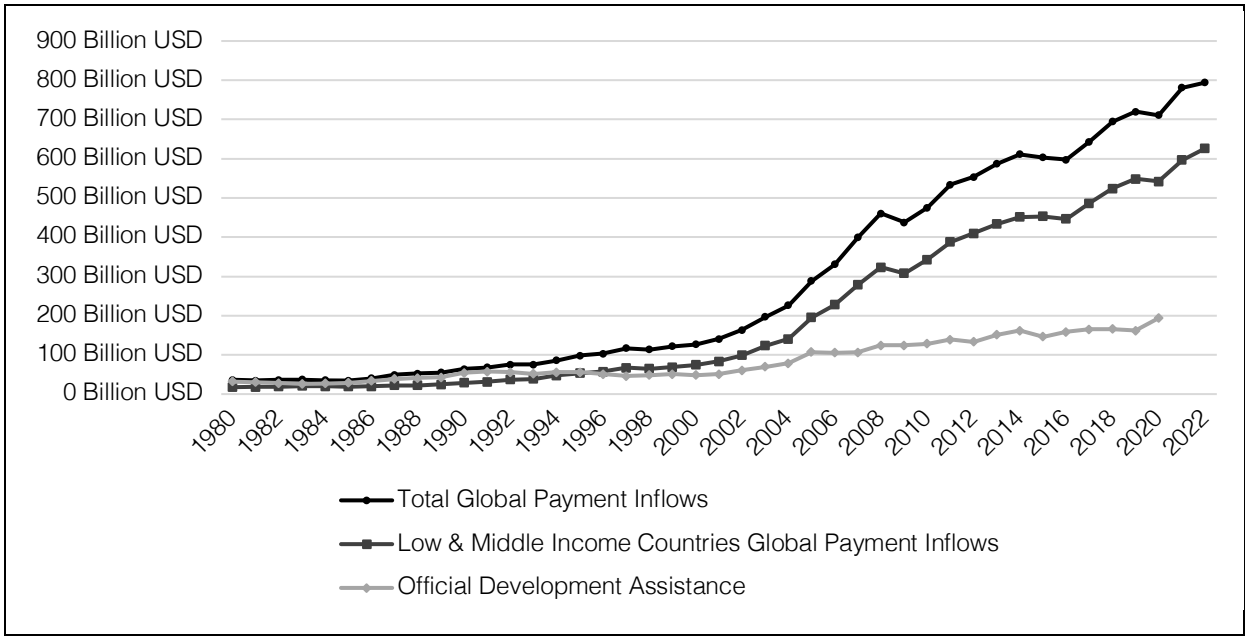

Figure 1. Global Payment Inflows to People and Official Development Assistance[4]

Meanwhile, there are practical issues concerning the development of the global payment infrastructure. There are calls by practitioners for "broad management perspectives" given that global payment infrastructure parts "do not operate in a vacuum" (BIS, 2008, p. 45,8). Executives part of the global payment infrastructure also tend to emphasise that it disintegrates or consolidates. Either new structures sometimes appear de novo, which creates silos in the global payment infrastructure, or the opposite, with a few structures prevailing (BIS, 2018a). This understanding is only sometimes clear and practical as it emphasises change over a temporally elongated development. Presently, for example, there are views of global payment infrastructure consolidation based on banks having a reduced number of connecting channels, services merging, and the concentration of global payment transactions among fewer global banks (BIS, 2008; Borio et al., 2020; Osterberg & Thomson, 1999). Concurrently, arguments exist for global payment infrastructure disintegration with the increasing global payment services following the application

global payment also appears to associate with developmental effects across Mediterranean countries (Glytsos, 2002). Among other indicators are the association of global payment and underlying technologies with terrorism and the subsequent legal and regulatory actions that implicate the aforementioned developmental indicators (Cook & Smith, 2011; Gutierrez, 2014; Vlcek, 2008).

[4] These data are available at worlbank.org under the data for remittance inflows and outflows and official development assistance.

of digital technologies and their argued disruption (Gomber et al., 2018; Hartmann et al., 2017; Shiller, 2003). Lastly, senior executives who are part of this infrastructure are experiencing its breakdowns, which remain difficult to manage. Following the quote opening this introduction, the boundaries we often think of in the global payment infrastructure fade in the face of breakdowns.

> "There was no movement in payments; a payment was a payment. And now… It's becoming so living and so boiling all of a sudden, that yeah, you don't know where to look first." — Senior executive

These calls by practitioners, unclear practical understandings, and experiences of breakdowns motivate this inquiry into how the global payment infrastructure develops and the quest for movement. The global payment infrastructure is critical for people's lives and without clearly delimited ends, so it does not simply transition from one form to another. While the global payment infrastructure develops without precedent, the infrastructure does not happen de novo, nor is it in situ. Understanding this development implies revealing movement because movement brings up non-linear continuities that background the stasis of a stable form and an overnight change.

Studies on Infrastructure Development Lack Movement

Information Infrastructure[5] studies often conceive infrastructure development through the persistence of infrastructure over time or a changing infrastructure without accounting for movement. These studies are sociotechnical, meaning infrastructure is as human as it is technical and material (Orlikowski & Scott, 2008; Sarker et al., 2019). In light of these intellectual grounds, infrastructure studies often use a network metaphor to define infrastructure. Broadly speaking, this network metaphor aims to convey that infrastructure is human, technological, and unbounded,

[5] As the chapter *Infrastructure Development* discusses, information infrastructure has different names across Information Systems, Science and Technology Studies, Information Science, Anthropology, Organisation and Management Studies, History, and Media Studies. Among these are large technical systems, telecommunication infrastructure, organisation infrastructure, thinking infrastructure, e-infrastructure, and digital infrastructure. The author uses information infrastructure to begin understanding and questioning this literature. However, the author consistently employs human and technological infrastructure, in short infrastructure, to convey the sociotechnical emphasis given by the different studies and fields. Lastly, the author refers to global payment infrastructure for theoretical and empirical understandings underlying this thesis research.

meaning no one actor is in control (Larkin, 2013) — many are (Bowker & Star, 1999; Ciborra et al., 2001; Hanseth et al., 1996; Star & Ruhleder, 1996).

Two main research streams regarding infrastructure development utilise the network metaphor. The first, acknowledges the *endurance of structure* and thus emphasises persistence. The emphasis is on past, (infra)structure,[6] which implies that infrastructure lasts (Ciborra, 2006; Star, 2002). For example, standards for keyboards, such as QWERTY, illustrate how future keyboards, e.g., in touch screens and mobile phones, cannot be entirely reinvented. The research here emphasises momentum, path dependency, and trajectory in infrastructure development (Hanseth, 2000; Hanseth & Modol, 2021; Henfridsson & Bygstad, 2013; Hughes, 1987; Mayntz & Hughes, 1988). However, as multiple structures interact in a network, there are usually tensions, which are oppositions and constraints. Accordingly, these studies also find drift (Ciborra et al., 2001), a slow and unplanned change before transitions happen (Hanseth & Modol, 2021). Overall, infrastructure development is non-linear despite past conditions because there are multiple structures and no actor in control. Still, this perspective foregrounds continuity in infrastructure development; past development conditions present and future infrastructure, even if the former does not determine the latter.

When change prevails in infrastructure development, there is discontinuity. A second research stream studies this discontinuity by acknowledging that there is an *outcome for structure*. This assumption means that rather than past conditions, infrastructure development takes place with present conditions, which tensions document. For instance, when one is sending a text message by phone, infrastructure is when such possibility is present and the phone's battery is charged. Structure, then, follows an outcome, a situated happening that occurs in practice. This stream emphasises activity and change — and relationships of the network metaphor.

The questioning shifts from what is an infrastructure to when is an infrastructure (Star & Ruhleder, 1996; Ribes & Finholt, 2009; Vaast & Walsham, 2009; Venters et al., 2014). When structure occasionally occurs following an outcome, there is infrastructure. Thus, (infra)structure becomes a present matter, an experienced occasion. It is in situ, improvised, constantly breaking up and creating new worlds (Bowker & Star, 1999; Ciborra, 2009; Star, 1990). In other words, this second perspective gives an ever-changing infrastructure, where discontinuity in

[6] As discussed below, this study differentiates between structure, a stable form, and infrastructure, which is beyond structure and is what precedes and proceeds structure.

infrastructure development takes the form of ongoing infrastructuring, the process of infrastructure creation (Reimers et al., 2022).

The insights of these two streams are unquestionable. However, these streams also tend to isolate infrastructure development through tensions, which do not account for movement and leave the development of the global payment infrastructure puzzling. As Figure 2 narrowly illustrates, the consequence of isolating infrastructure development is an overemphasis on either persistence or change, which recreates the anomaly of continuity in the global payment infrastructure. Whereas endurance of structure brings up continuity as persistence through an enduring structure staying still, an outcome for structure brings up continuous change and a discontinuous situated infrastructure occasion.

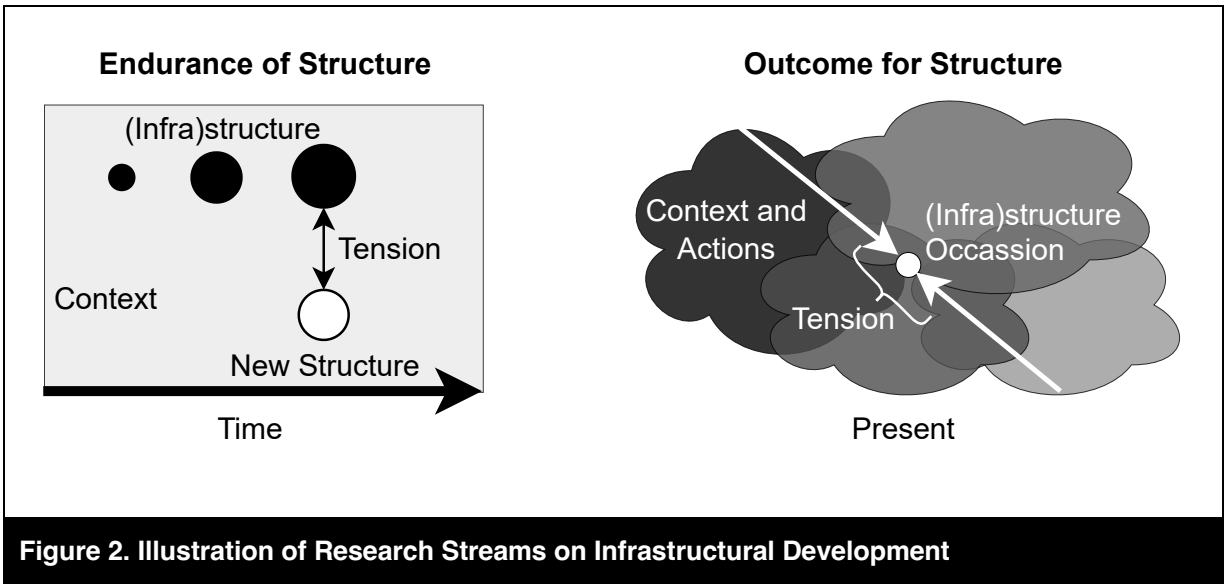

Figure 2. Illustration of Research Streams on Infrastructural Development

Moreover, we are in the midst of what is often called a digital transformation in global payment infrastructure and beyond (Gomber et al., 2018), which raises ethical concerns. This epoch commonly reveals itself through differences and conflict, as experienced across the global payment infrastructure. In this epoch and its breakdowns, tensions recreate conflict and exclusions because they bring up stasis and isolation in infrastructure development. Meanwhile, calls for inclusion and sustainability are at the centre of debates about the global payment infrastructure (United Nations, 1987, 2015). Thus, there is an ethical need for movement, which brings up a temporally elongated change without a transcendental stasis that recreates exclusions and conflict in the development of global payment infrastructure.

Lastly, it is well known that in the study of infrastructure, "scholars cannot assume a single and stable level of analysis" (Hanseth & Modol, 2021, p. 147). The creation of infrastructure is a never-ending process (Reimers et al., 2022) because infrastructure is unbounded (Ciborra & Hanseth, 1998; Star & Ruhleder, 1996). Not only is infrastructure unbounded, but its development is temporally long with continuous heterogeneous processes (Hanseth & Modol, 2021; Monteiro, 2022; Scott & Orlikowski, 2021), which supports present calls for sociotechnical theory that goes beyond tensions (Mousavi Baygi et al., 2021).

In synthesis, movement is lacking in infrastructure studies for addressing how the global payment infrastructure develops. Because movement is temporally long and conveys change, theoretically, addressing infrastructure development with movement unravels phenomena such as the development of global payment infrastructure. Practically, movement helps to understand and create non-linear continuities to act wisely (Burton-Jones et al., 2021) and manage breakdowns in the global payment infrastructure. Ethically, because movement is natural, meaning it does not convey any transcendence, it brings up continuity in an inclusive and non-conflicting manner while still accounting for change. There is a necessity to reveal movement in infrastructure development.

Outline of the Inquiry into Global Payment Infrastructure Development

Before sketching out this inquiry's outline, some definitions are worth reviewing. An anomaly is an unexpected, empirical, and theoretical finding which leads towards "creative and novel theoretical insights" (Timmermans & Tavory, 2012, p. 180). The meaning of revealing is similar because the term conveys a critical inquiry where there is a concealed human understanding. Thus, revealing is "bringing into appearance and concrete imagery" (Heidegger, 1977, p. 10). Development is a temporally long process that includes change as a difference in form (Van de ven & Poole, 1995). However, this study attends more to the temporally long quality development conveys. Lastly, the inquiry's quest into how the global payment infrastructure develops also needs a definition of infrastructure, which is a type of technology. Traditionally, technology is a "branch of learning" concerned with "an art or craft" (Heidegger, 1977; Marx, 2010, p. 562). Accordingly, infrastructure conveys a continuous crafting that combines the human, technical,

and material (Sarker et al., 2019). Thus, this work differentiates between a structure, a stable form, and infrastructure, which is the underlying way a stable form is and develops.

After the present introduction, this inquiry unfolds through seven chapters. Chapter Two, *A Historical Bricolage of Global Payment Infrastructure*, traces, through a bricolage of histories, the global payment infrastructure's unprecedented and temporally long development. These histories contextualise the study and serve as a background for the puzzling development of the global payment infrastructure. This chapter allows dialogue with the empirical context before the inquiry revisits assumptions in infrastructure studies (Monteiro et al., 2022).

Chapter Three, *Infrastructure Development*, reappraises Information Infrastructure studies to inform how the global payment infrastructure develops. Following the processual and ecological grounds of such studies (Ciborra, 2006; Ciborra & Hanseth, 1998; Star & Ruhleder, 1996), this chapter concludes with assumptions for movement, which help to address the anomaly of continuity in global payment infrastructure. These assumptions build from Martin Heidegger's analysis of technology and the ecology of mind Gregory Bateson brings (Bateson, 1972; Heidegger, 1977). The thesis, *it is along ways*, is the conclusion of this third chapter. The author uses this rather alien phrase to highlight ontological assumptions, *it is*. *Ways* follow Heidegger's analysis of technology and should be understood as all the meanings commonly attributed to the word in English. These meanings include manners, forms, paths, routes, motions, methods, styles, states, and directions, among others the reader may think of. Similar is the case with the word *along*, which goes beyond Bateson's ecology of mind and conveys being in company with others, extending horizontally, motion, and the passing of time, among others. Therefore, movement is not a simple transition after defining an end—for example, a position or structure that does not move.

The inquiry continues with Chapter Four, *Case Study of Global Payment Infrastructure 1973–2030*. The chapter examines the global payment infrastructure's data corpus, covering its present, past, and future, through three types of accounts. The first ones are situated accounts of four organisations documenting the period 2011–2020. The data here include 123 hours of observations, 12 interviews with senior executives, and 9,000 files. The second ones are purposefully sampled historical accounts, including one book about SWIFT's history, and 115 other reports and studies, mainly from the Bank for International Settlement. These historical accounts document the period 1973–2021. Lastly, narrative accounts provide a retrospective and prospective perspective until 2030; these include 22 in-depth interviews with senior executives, also purposefully sampled. Abductive principles guide iterative data analysis and collection

(Peirce, 1998; Timmermans & Tavory, 2012). The analysis leads away from the endurance of or outcome for structure towards the ways structure is and develops. Metaphorical narratives (Czarniawska, 1997, 2004) give an ecologically ongoing understanding conveying such infrastructural ways (Bateson, 1972; Heidegger, 1966, 1977).

Chapter Five, *Global Payment Infrastructure Development Part I*, and Chapter Six, *Global Payment Infrastructure Development Part II*, present the inquiry's findings. Chapter Five introduces three infrastructural *ways* for global payment. First, granular homogenisation conveys movement for global payment to be objects. The second narrative, irreversible validation, conveys movement for global payment to pass as real, as a valid past event. The last way is ubiquitous causation, which conveys movement for global payment to result from action. These infrastructural ways are inherently historical and extend along the period 1973–2030. Further, they are not in isolation; they are and develop along with each other. Chapter Six presents hurtling, swaying, and rippling, which are the different infrastructural ways for global payment that are *along*. Respectively, these infrastructural ways underlie the creation of new global payment data, new illicit global payment, and new global payment locations. Both of these chapters' findings answer with movement how the global payment infrastructure develops.

The inquiry finishes with Chapter Seven, *Infrastructure Development Along Ways,* and Chapter Eight, *Closing Remarks on Movement in Infrastructure Development and Beyond.* Chapter Seven presents the contribution of along ways as an ontological approach for revealing movement in infrastructure development. It seeks to move past the current tendency in the literature to either highlight persistence or change and isolate infrastructure development through tensions. This chapter also considers the practical and ethical implications raised by this study, especially concerning the breakdowns in the global payment infrastructure. Finally, Chapter Eight summarises, overviews limitations, and offers a starting line for further sociotechnical research in this area. Such a starting line not only engages with but also builds on the insightful sociotechnical tradition of infrastructure studies and the information systems field (Mousavi Baygi et al., 2021; Pentland et al., 2017; Riemer & Johnston, 2017; Scott & Orlikowski, 2021). Thus, this study also differentiates from other relevant fields addressing movement while opaquing technology, as is the case with Philosophy (Nail, 2019), Anthropology (Ingold, 2000, 2021), and Organisation and Management (Chia, 1999; Introna, 2019; Langley et al., 2013; Tsoukas & Chia, 2002).

CHAPTER TWO

A Historical Bricolage of Global Payment Infrastructure

This chapter presents the global payment infrastructure with a bricolage of histories. The definition of global payment as exchange across borders and currencies offers a starting point (Giraldo-Mora et al., 2020; Simmel, 1978). Following this definition, global payment and its infrastructure are not apart. If there is no global payment, there is no infrastructure. The global payment infrastructure does global payment and does not reside within a country, organisation, person, or a single global payment transfer. Therefore, we should think in terms of a bricolage of histories of infrastructure, including the accumulating and changing payment instruments, regulations, institutions, providers, and related practices and technologies for global exchange.

As Figure 3 below illustrates, this historical bricolage of global payment infrastructure begins with the Medici family and paper payment instruments and ledgers. Next, central banking and correspondent banking continue, thus establishing organisations that enhance stability in foreign exchange, the practice of exchanging between currencies. Then, telecommunication, central banking cooperation, payment cards, and global payment standards extend the global and systemic understanding of payment infrastructure. Digital payment instruments and blockchain, lastly, outline some recent infrastructure histories. As it traces these histories, this chapter questions the development of the global payment infrastructure. Indeed, it appears such development is without precedent, meaning as never experienced before. However, these histories also show the global payment infrastructure develops with time and with the accumulation of infrastructure. The chapter ends by drawing attention to continuity and discontinuity in the development of the global payment infrastructure.

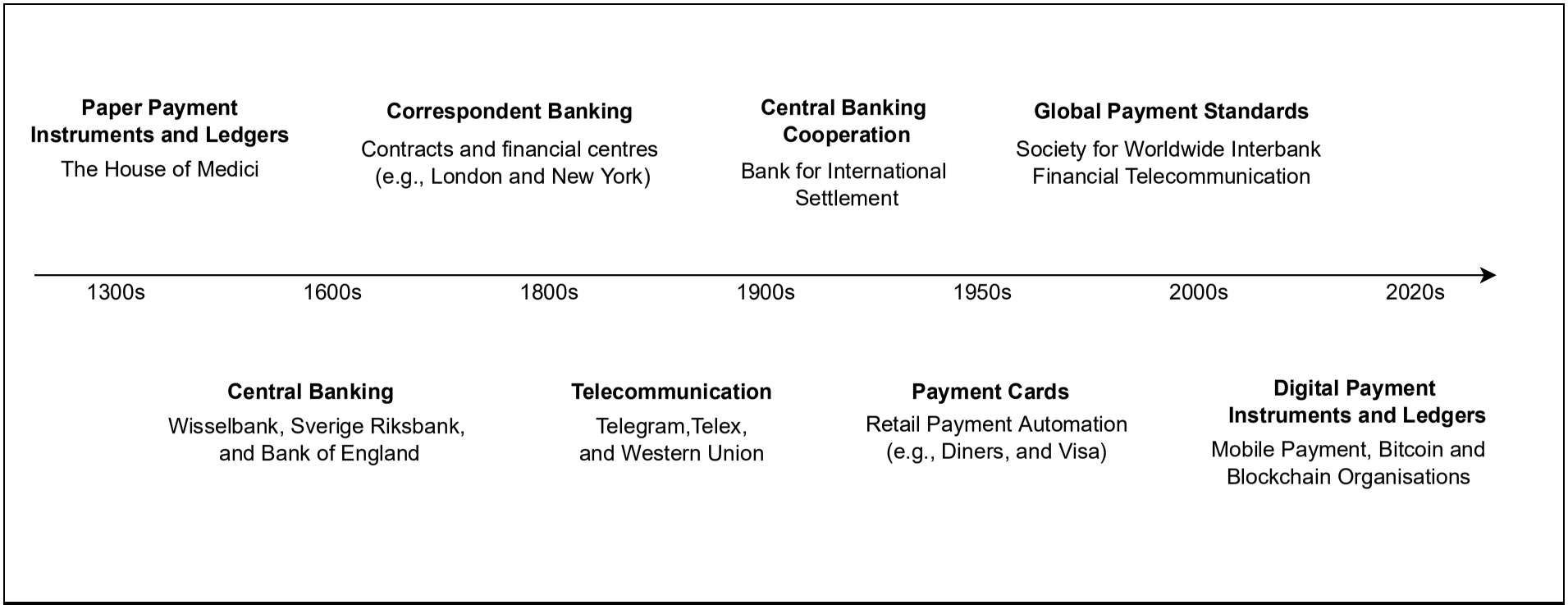

Figure 3. Histories of Global Payment Infrastructure

Paper Payment Instruments and Ledgers

Contemporary global payment infrastructure involves payment instruments, tools, ledgers, and data records that the establishment of the House of Medici helps trace. The family began as foreign exchange dealers in a time when most currencies in circulation were literally coinage of various valuable metals, especially gold and silver. The plethora of coinage instruments, and the difficulty of determining exchange value between them, made long-distance payments difficult. By improving exchange services, the House of Medici became among the wealthiest families in Europe (Ferguson, 2008). Even though the growth and influence of the family started in Italy, the family came to influence and expand across Europe through the Medici Bank and its underlying paper payment instruments and ledgers. Many of the Medici's innovations, such as double-entry accounting systems are still prominent in today's global payment infrastructure.

The powerful Medici family began at humble tables in the streets of Italy. Before 1390, the family members were considered more gangsters than bankers, with five of its members sentenced to death for capital crimes (Ferguson, 2008). It was until Giovanni di Bicci de Medici that the family house grew and became influential through its Medici Bank. The Medici Bank was the largest bank of its time, with branches in Venice, Rome, Milan, London, Bruges, Avignon, Geneva, and Florence (de Roover, 1946a). Among the family members that illustrate the Medici's influence are Popes Leo X and Clement VII, Queens of France Catherine and Marie, and the dukes of Florence, Nemours, and Tuscany (Ferguson, 2008). In addition, the family came to support and influence artists and scientists, from Michelangelo to Galileo, and today one still sees ample examples of the family's architectural influence in the streets of Italy (Ferguson, 2008).

Many fewer kinds of banks than today existed during the era of the Medici Bank times (1397–1494). To engage in banking was simply to engage in exchange (de Roover, 1946b), and four types of organisations were referred to as banks (de Roover, 1946a). "Banchi de pegno" was a licensed pawnbroker offering loans for personal items for a rate of four pence per pound a month, or 20 per cent a year. "Banchi a minute" was a retail bank, likely involved in offering loans for jewels, the credit sale of jewellery based on an instalment plan, and money changing. However, this bank was not a deposit bank as commonly known today. "Banchi in mercato" was a money changer performing foreign exchange deals in the street of Italy and writing these in books in front of their customers by law. Finally, the Medici Bank became part of "banchi grossi," or great banks. These banks did business through offices and dealt with global payment. As such, the Medici

"were traders as well as bankers. They combined foreign trade and dealings in exchange–not petty exchange of foreign for domestic coins, but trade in bills of exchange" (de Roover, 1946a, p. 26).

The essence of the Medici's family business and its bank's global payment services resides in the use of Bills of Exchange. Bills of Exchange — the precursor to today's checks — served as paper payment instruments that extended coinage to holographic documents. These global payment instruments involved credit and exchange transactions. They involved a future date payment that would take place in a foreign currency and in a different location (de Roover, 1946b). For example, a payment could involve the Medici Bank's branches in Florence and London.

Further, there were four types of bills of exchange: (1) those drawn by the principal on its agent (2) or the other way around, and (3) those remitted by the principal to his agent (4) or vice versa (de Roover, 1946b). Bills of exchange were traded in their issuance and payout markets. Even though these instruments were not discounted, because the Church condemned charging interest as usury, charges were still applied. The Medici Bank would claim a profit if the exchange rates changed in their favour at the end of two months, when bills of exchange reached their maturity.

Underlying the Medici Bank's global payment services was a double-entry accounting system (de Roover, 1946b; Ferguson, 2008). The principal was the bank branch or individual who initiated the transaction and took the risk. At the same time, the agent was the bank branch or individual who carried out the orders from a foreign principal (de Roover, 1946b). Each branch in the Medici Bank would act as a principal and agent for the rest of the branches. Such was the case for outside branches that served as payment and banking partners in regions that the Medici Bank did not directly serve. Principals opened Nostro ("for our account") accounts for their agents. Conversely, agents opened Vostro ("for your account") accounts to foreign correspondents (de Roover, 1946b).

As such, global payment involved updates in Nostro and Vostro accounts as well as the creation and management of payment data (de Roover, 1944, 1946b). The Nostro account of principals involved balances in foreign currency for agents and the local currency with which a payment was initiated. The balance difference represented either a profit or a loss from exchange transactions. In contrast, Vostro accounts were only maintained in local currency for bills that were paid, sold, or collected for their principals. Even though these accounts didn't include exchange rates, they incurred charges for commissions. When payment was carried out, the Nostro account of the principal would be charged with the remittance, and the bank's holdings in foreign currency would increase. Similarly, the bill of exchange would be written to debit the Vostro

account of the correspondent, whose balance in local currency would reduce. The Medici's branches acted as both principal and agents in carrying out these procedures, as was the case for outsider partnering banks.

This first global payment service was supported by the "libro segreto," the secret book, of Giovanni di Bicci de Medici. This book recorded all changes in the family's bank transactions data (Ferguson, 2008). It allowed the House of Medici to coordinate and keep a central record of its global payment and accounting system while facilitating a scaled form of trade finance, with payment of coinage represented in bills of exchange instruments. The secret book of Giovanni does not follow the rigour of today's accounting standards (Ferguson, 2008). However, it illustrates how the Medici Bank kept records of its branches while also allowing for ample local independence.

Legally, the Medici Bank followed a decentralised organisation with various partnerships in its global payment and banking set-up (de Roover, 1946a). During the 1300s and 1400s, it was common for banks to be established with a central legal organisation that owned offices in various cities and employed managers in these different offices. Accordingly, a tight partnership existed between the head office and its branches, and the head of the firm would centrally decide any changes or strategies. In contrast, the Medici Bank followed a decentralised legal organisation, with different partnerships at its home office in Florence and at its European branches (de Roover, 1946a). Each partnership was a separate legal entity with its own management style, capital, books, and profits. As such, each family branch dealt with each other as if they were outsiders, while the home office resembled what today we call a holding company. Furthermore, each of the family partnerships included individual managers who also earned a share of profits rather than a fixed employee salary.

Even though the Medici Bank followed a decentralised legal organisation, it operated with controls that resemble those of today's holding companies (de Roover, 1946a). The Medici family held at least fifty per cent of their subsidiary partners' capital. According to partnership agreements, senior partners held the most power and had the right to terminate junior partners who carried the burden of managing day-to-day activities. When partnerships were drafted, these came with written instructions, which provided business and credit practices compared with the association articles of the Medici Bank. Moreover, not everyone was allowed to make bills of exchange. There were three managers in the main office in Florence with this right, and outside correspondents also had to be authorised to handwrite bills of exchange (de Roover, 1946b).

No one specific cause drove the decline of the Medici. However, scholars have described the Bank's loose management, deteriorating market conditions, and excessive reliance on external capital (de Roover, 1943; de Roover, 1947). After 1429, Cosimo De'Medici succeeded his father Giovanni di Bicci de Medici; he continued the expansion of the Bank's core banking functions and also expanded into wool and silk manufacturing. Cosimo's successors, Piero and Lorenzo de Medici, relaxed the management of the bank, giving more freeway for managers. Furthermore, during Lorenzo's time, important changes in market conditions took place. Among these was a decline in gold prices, the currency used for repaying deposits at the Medici Bank (de Roover, 1947). Compounding the effects of these poor market conditions were the excessive reliance on funds from depositors for global payment and foreign exchange transactions and a failure to reinvest earnings. Loose management during a time of poor market conditions allowed for the higher (and risky) use of borrowed capital and, over time, the decline of the House of Medici.

Today's global payment infrastructure includes the instruments and ledgers the Medici Bank illustrates. To be sure, many important financial instruments predated the Medici's and were widely used during the 1300s and 1400s (Kohn, 2001, 2020), but the Medici Bank greatly enhanced them (de Roover, 1963; Goldthwaite, 1987; Parks, 2005). Moreover, the use of paper payment instruments, legal decentralisation, correspondents and agents, and relational banking models following double-entry accounting practices, as well as Nostro and Vostro accounts, are continuously practised nowadays. Put another way, these acivities still form the core of today's global payment infrastructure (Kohn, 2001, 2020). At the same time, of course, as we will see in subsequent sections on central banking and correspondent banking, the global payment infrastructure is beyond the banking practices era of the Medici.

Central Banking

Even though there is no consensus on the relationship between central banking and the global payment infrastructure, the former is an important part of the latter. Most historical accounts of central banking variously stress its involvement as an intermediary credit offeror for banks, lender of last resource, money maker, and legal authority involved in the establishment of government organisations. The Dutch Wisselbank illustrates the emergence of the central banking role in payment as a credit organisation separate from commercial banks (Quinn & Roberds, 2007; Ugolini, 2017). Conversely, Riksens Ständers in Sweden was the first organisation to issue cash

and practice fractional reserve banking practices (Ferguson, 2008). Lastly, the Bank of England was crucially a lender of last resort and, at times, directly intervened in governmental finances.

The establishment of the Bank of England in 1694 (following soon after the so-called Glorious Revolution) and its scholarly recognition as a lender of last resource in 1870 illustrates the close ties between central banking and governance (Capie et al., 1994; Goodhart, 1988; Ugolini, 2017). From this view, central banking is the governing practice that allows global payment to continue functioning. As a government organisation, the Bank of England came to have distinctive privileges and involvements in payment. The bank participated in financing the Crown's wars, and, in 1742, it issued banknotes without barning interest or need for a current account (Ferguson, 2008). These actions resemble recent activities of central banking. Indeed, like modern central banks, the Bank of England promoted price stability and financial progression and supported the state's financing needs during crises (Goodhart, 1988, 2010). The scholarly acknowledgement of the Bank of England as the lender of last resource in 1870 takes place along with other central banks such as the Banco de Portugal, the Bank of Finland, the Nederlandsche Bank, and the Austrian National Bank (Capie et al., 1994). At the same time, scholars have shown the links between central banking practices associated with the Bank of England and Medici Bank. Such research also discusses the processes of clearing and settlement, which are further detailed in the next section (Quinn, 1997; Ugolini, 2018).

Accounts following the establishment of the Riksens Ständers in 1668 emphasise central banking's association with fractional reserve banking. From this perspective, central banking means funds creation, which underlies global payment. The practice of central banks retaining a fraction of assets as reserves while loaning out remaining funds took form with the Riksens Ständers bank. The establishment of the Riksens Ständers bank followed a bank run at Stockholm's Banco, a sort of trial run of central banking in Sweden. Following the closure of Stockholm's Banco, the Riksens Ständers bank was established on the premise that a central bank should not be private, overissue notes, or lend on unsafe collateral (Fregert, 2018). The Riksens Ständers bank, then, was established with a lending and exchange department and was independent of the government. The set-up took inspiration from Amsterdam's Lehnebank, which would lend funds based on the reserves at the Wisselbank (Fregert, 2018). However, Sweden's new central bank was public and consolidated into one organisation, the Riksens Ständers bank.

Even though the histories that the Bank of England and the Riksens Ständers bank demonstrate, the establishment of Wisselbank, Amsterdam Exchange Bank, in 1609, better illustrates the role of central banks as a credit offeror for banks and its part in the global payment

infrastructure (Quinn & Roberds, 2007). The establishment of the Wisselbank more closely follows global payment devices used by the Medici Bank. Dutch authorities set up Wisselbank after the need to control the debasement of the various currencies used in the 1600s by banking organisations (Schnabel & Shin, 2006). Accordingly, the bank aimed to regulate coin prices. Nonetheless, the debasement problem was not easily solved by rigid standardisation. Instead, it was until the creation of the coin price was officially accepted to differ at the Wisselbank and in inter-bank global payments from that of the low-value global payments market price that some stability took place (Quinn & Roberds, 2007).

To grasp the historical role that the Wisselbank plays in central banking, it is worth clarifying today's views on clearing and settlement. In practice, clearing refers to the "confirming of amounts in payment," while settlement is "the transfers of funds" that "extinguishes bank's obligations" (Norman et al., 2011, p. 5). More legally binding definitions outline clearing as "the process of transmitting, reconciling and, in some cases, confirming transfer orders prior to settlement, potentially including the netting of orders and the establishment of final positions for settlement" (ECB, 2009, p. 5). Settlement, on the other hand, is "the completion of a transaction or of processing with the aim of discharging participants' obligations through the transfer of funds and/or securities" (ECB, 2009, p. 24). In interbank payments — the payment between banks — settlement takes place in central bank money (Norman et al., 2011). This current practice is traceable to the settlement and clearing practices of the Wisselbank.

The establishment of the Wisselbank in 1609 aimed to guarantee the authenticity of coins upon withdrawal (Quinn & Roberds, 2007). The bank took deposits, offered withdrawals with a fee, was owned by the city council, and, contrary to Riksens Ständers bank, it did not lend. Instead, the bank maintained nearly a one hundred per cent ratio between its deposits and reserves, and thus minimised the risk of bank runs (Ferguson, 2008). The rationale followed the bank's aim of guaranteeing the quality of coins upon withdrawal during a time when these were being debased by cashiers throughout the city. They were collecting quality coins and taking part in their transport to illicit mints, which would take them to produce lighter versions that were to be paid out by cashiers in exchange for bills of exchange or other local payment instruments (Quinn & Roberds, 2009). Following unsuccessful attempts to ban cashiers, the Amsterdam city council established Wisselbank to guarantee the authenticity of coins.

However, the bank's aim to maintain price and quality further debased the currencies it aimed to stabilise (Quinn & Roberds, 2007, 2009). While most market transactions took place outside Wisselbank's services, the bank assessed the quality of coins prior to their deposit to

maintain quality (Schnabel & Shin, 2006). This guarantee of the coin's quality and the reduced uncertainty provided by Wisselbank meant the local currency used at the time, rixdollars, acquired two different prices. The currency increased in value at the bank, while its market price differed. This difference led to a premium exchange rate ("agio"), which mediated both payments, meaning large-value interbank payments at the Wisselbank and low-value market payments by cashiers. In the beginning, however, Wisselbank raised the market value of rixdollars and started setting prices for foreign coins in circulation to accommodate for this price difference and to stabilise the debasement of new coins (Quinn & Roberds, 2007). However, this effort to maintain price stability seems to have exacerbated the debasement of currencies. It became profitable to melt coins from one currency to make new ones in different currencies at different periods.

It was not until Wisselbank acknowledged the dual price of the currency that its subsequent market developments and the formation of two payment types facilitated the better management of debasements. Subsequent to the unsuccessful aims to maintain price stability, in 1640, authorities reluctantly began to tolerate the mismatch in prices, which led to the "agio" exchange rate (Quinn & Roberds, 2007). Following the Dutch authorities' introduction of a new local currency in 1659, the bank also began to formally supply inter-bank settlements of large-value transactions (Quinn & Roberds, 2007). Even though deposits were still being accepted, the acceptance of a dual price for the same currency facilitated the formation of payments outside the bank through which cashiers would trade and profit following the agio exchange rate. This market prevented a greater debasement and allowed the formation of inter-bank settlement of high-value payment transactions at Wisselbank, while outside payments supported low-value payment transactions. Over time, this setting came to reduce the need for deposit withdrawal at the bank. The Dutch authorities took measurements for the unlikely and unexpected withdrawal of deposits without a valid instrument (receipt), which was traded at banks and by cashiers (Quinn & Roberds, 2007). "The result was a fiat bank money used as a settlement for high-value transactions in Amsterdam and, by extension, international transactions that used Amsterdam as a hub" and "a 100-year period of remarkable monetary stability" (Quinn & Roberds, 2007, pp. 264, 265).

The association of central banking with global payment infrastructure, however, does not rely on a single central bank. As one scholar put it, the "important point to grasp is that with the spread throughout the Western world of a) cashless intra-bank and inter-bank transactions b) fractional reserve banking and c) central banks monopolies on note issue, the very nature of money evolved in a profoundly important way" (Ferguson, 2008, p. 51). Globally, central banking

involvement and its association with intra-bank and inter-bank payment transactions are part of the global payment infrastructure, which historically continues with correspondent banking.

Correspondent Banking

We now turn to the clearing and settlement of global payment transactions, which goes beyond central banks to the establishment of correspondent banking. That is, the clearing of funds and their settlement in global payment, which resides with banks that work as intermediaries for other banks. Thus, historical accounts of correspondent banking note that it underlies "the settlement of international trade payments, the bread and butter of international banking" (Merrett, 1995, p. 70; Norman et al., 2011; Panza & Merrett, 2019). With no global central banking organisation, correspondent banking is arguably the main organisational form for global payment transactions between banks (Merrett, 1995).

Though their key developments came after the era of the creation of central banks, correspondent banking is also traceable to Italy's Medici Bank and the earlier establishment of what we call the deposit bank (Fratianni & Spinelli, 2005). During preindustrial Europe, correspondent banking arrangements proceeded from payment instruments that abstracted, through credit, the use of coinage and subsequently facilitated payment across long distances (Quinn, 1997). Among these first instruments is "cambium," a promissory note drawn formally by a notary and used in the late twelfth century (Kohn, 2020). Merchants used this contract to secure payment transactions at a different place, in a foreign currency, and at a specified date when the parties concerned and their agents had to be present for the repayment. This instrument and similar other ones, such as the "letter obligatory," were legally binding contracts that allowed for clearing accounts without transporting coinage. Coinage was not only difficult and expensive to transport but also to maintain in a standard weighting quality. Within countries, these instruments predate bills of exchange and are traced back to payment systems supporting medieval fairs and inter-fair payment transactions, which also illustrates Italy's outsized influence on payment systems (Fratianni & Spinelli, 2005). Globally, the establishment of financial centres across Europe and central banking in the 1600s continues from these past instruments and materialises in correspondent banking arrangements for global payment (Nogues-Marco, 2020).

From the 1800s to the mid-1900s, correspondent banking relations matured into the preferred arrangement for global payment transactions. Correspondent banking allows for the

standardisation of contracts and promotes creditworthiness and trustworthiness. In addition, corresponding banking contracts monitor (and thus normalise) banking relations by giving detailed accounts of branches and fees, as well as credit and reporting requirements; over time, such information has expanded while maintaining a standard format (Merrett, 1995). Many scholars argue that multinational banking has remained scarce compared to the ubiquity of corresponding banking relations (Merrett, 1995; Panza & Merrett, 2019).

The correspondent banking relations of Australian banks between 1830 and 1960 is worth noting. These banks developed monitoring practices across the industry, enabling clearing and settlement of global payment transactions (Merrett, 1995). Foreign departments were established to conduct visits at correspondent branches. Specialists advised senior managers on the setting of credit limits. Further, Australian banks relied on various correspondents in the same country and maintained credit limits to a minimum. This splitting of business also came with the assumption and need to have multiple agents initiating payment transactions on their side. There were also assurances for the settlement of transactions. For example, some agents would check that there were enough funds available, while, in other cases, clearing funds would be performed unless otherwise stated. Australian banks also capped their credit limits to agents from Asian countries, the Philippines, communist countries, Japan, Ceylon, and some European and Mediterranean countries. Lastly, with some banks, the issuance of letters of credit or bills of exchange for global payment was drafted against Australian banks only if assurance of settlement was provided, and customers were advised of the non-responsibility of payment by Australian banks.

Austria is just one example, The establishment of correspondent relationships relates to many great financial centres, and above all London. The city "was described as the clearing house of the world and the Sterling bill as a form of international currency" (Baster, 1937, p. 294). With this concentration of correspondent banking came enhanced mutual oversight between banks. As Merret (1995, p. 81) puts it, nearly "every bank in the world involved in international transactions possessed a London agent… the creditworthiness and trustworthiness of most of the banks in the world involved the provision of international financial services was concentrated in the city of London." Banks had much interest in having a good reputation for the growth and maintenance of global payment businesses. These businesses grew through correspondent banking relationships and the credit and foreign exchange that came with them.

Broadly, correspondent banking links to credit, data sharing, and increased profits by hedging high-value global payment transactions. This business was particularly attractive from 1880 to 1960, when banks enjoyed a very profitable mix of fixed and percentage charges. Further,

the concentration of correspondent banking relations promoted the sharing of risk; any default on payment would be easily shared among banking organisations. These activities and the ease of entering into correspondent banking relations through a standardised contract may help explain the rise of large banks in several industrialised nations and the relative scarcity of multinational banks (Merrett, 1995; Panza & Merrett, 2019). Or, as framed in different research, correspondent banking relations took place because banks were seeking a multinational expansion in new countries and regions where they lacked information and access (Battilossi, 2006).

Indeed, other centres for global payment transactions emerged following the concentration of correspondent banking in London. Notable are New York, Paris, and an independent exchange system among German banks (Baster, 1937). London declined as a banking centre after World War One. In addition, during such war, banks in London were pressured to follow the relaxation of American eligibility rules for correspondent relationships. Specifically, banks in London were forced to continue their business and growth with banks in Germany (Baster, 1937).

Global payment infrastructure extends beyond the relationships and centres described above. This infrastructure includes bills of exchange and the different activities these fostered prior to the concentration of correspondent banking relations (Nogues-Marco, 2020). Thus, it is challenging to set apart the instruments and technical activities implicated in the growth of correspondent banking; especially, those technical activities that came with the application of electricity and light. Telecommunication and its part in the global payment infrastructure are thus addressed in the following section, which, in particular, covers the telegram, Telex, and Western Union.

Telecommunication

Global payment infrastructure extends to telecommunication and telegram technology, which vastly expanded the connectivity and speed in global payment transactions. In the 1800s, telegram technology took place with the management of electricity to create faster and much more interconnected long-distance networks. The Telegram came to be used for payment messages between banks and as an alternative for paper transport. Thus, faster communication with the use of electricity took place with the set-up of telegram lines and technology, which the establishment of Telex and Western Union document. Telex served banking payment networks, while Western Union's telegram technology provided the grounds for global payment among individuals.

The establishment of telegraphy follows a long and global history (Beauchamp, 2001). Germane to our story of global payment infrastructure is the application of electricity, switches, keyboards, and wired and wireless networks. However, before electricity was applied, inventors envisioned a mechanical telegram. The 1600s saw a shutter system consisting of large wooden structures set up on hills in the UK and Sweden. These wooden structures had shutters for coding and decoding messages by sight. The Chappé's telegraph, consisting of a large towel and the use of telescopes, followed. This second mechanical telegraph became known as the semaphore telegraph system and was adopted globally (Beauchamp, 2001). These two systems are part of the background preceding the application of electricity for telecommunication during the 1800s.

The use of electricity for telecommunication can be traced to the rise of the electrical battery and electrical engineering (Carré, 1993). Even though nascent electrostatic and electrochemical devices existed between 1753 and 1848, these inventions remained inefficient compared to the semaphore system (Beauchamp, 2001). It was the discovery of the electromagnet that spurred the creation of the telegram. Hans Christian Ørsted, a Danish physicist, found that a "magnetic needle is deflected at the right angles to a wire carrying an electric current when the wire is located close to the needle" (Beauchamp, 2001, p. 25). Then, two French men, André-Marie Ampère and François Arago, further scaled the discovery with a telegram prototype. The telegram application expanded worldwide with various research, inventions, cable networks, transatlantic cables, microwave and wireless technology, and telegram prototypes for operating railway and military operations (Beauchamp, 2001). These all document the global payment infrastructure.

Commercially, however, the telegram took shape with the application of the Morse system for coding and decoding messages. The system was based on two simple ideas. The first was the production of signals with a mechanical device. When operated, a device would close an electrical circuit, causing a similar movement in a receiving device. The second was the application of serial code formed by sequential combinations of two different types of signals, which allowed for the encoding and decoding of all letters of the alphabet (Carré, 1993). Compared to its predecessor, the needle system, the Morse system was quickly adapted as standard for telegram messages worldwide for its reliability, speed, and ease of operations. Morse devices were applied across telegraph networks for commercial and private use. From 1837 until 1910, the Morse system was the standard telecommunication system, with the last message using the system taking place on the 1st of February 1999 (Beauchamp, 2001).

The growth and use of the commercial Telegram led to further extensions of the product itself, given the ongoing need for additional speed and efficiency. In 1854, David E. Hughes prototyped a telegraph printer. The printer was formed by a set of keys an operator would press to send a message, which would trigger a strip of paper onto a rotating wheel and, subsequently, the printing of the letter. Thus, there was a synchronicity between telegraph devices and twice the speed for messages using the Hughes coding system. Despite these improvements, the circuit's efficiency needed enhancing during the 1870s.

Enter the active involvement of governments (Carré, 1993) and telecommunication organisations. In England in 1837, electric telegram lines were extended together with railway networks to facilitate their operations. In France, electronic telegraph lines emerged ten years later, as many feared a lack of visibility in messages compared to the pre-electric-lines standard of Chappé's telegraph. In the United States, twenty companies competed. American Telegraph and the New York and Mississippi Valley Printing Telegraph Company, both established in 1856 (Carré, 1993; Rotenstein, 2006), merged in 1866. The merger resulted in the first transcontinental telegraph line and a century-long telecommunication monopoly in the United States under the Western Union banner (Connolly, 2014; Wolff, 2013).

During the remainder of the nineteenth century, telegram technology improved dramatically. In particular, Emile Baudot established a new system (Beauchamp, 2001). In printing telegraphs such as the Hughes telegraph, the line was idle most of the time, as the speed of transmission was greater than what a single operator could manage. The Baudot system, however, was among the first to offer time-division multiplex. Through a rotating mechanism, the system allowed multiple operators to share a single telegraph line with a rotating mechanism that would set time windows for the use of the line. Still, the keyboard and code needed for the Baudot system were difficult to operate and learn.

Following these difficulties, the establishment of the Telex — teleprinter and exchange — network saw the application to telegram technology of typewrites and telephone lines (Beauchamp, 2001). In 1876, Alexander Graham Bell began experimenting with the telephone's commercial use, and he imagined from the start would replace the telegram. However, the telegram offered stability and security in communication that the telephone could not. The typewriter also allowed for the use of familiar keyboards in telegram systems. These changes led to increased speeds and the application and the development of teleprinting services in telephone companies, such as Graham's AT&T.

Thus, Telex came as a further solution for businesses to improve speeds and services in 1932 (Beauchamp, 2001). Following their application of the Telephone and previously Telegram services, businesses easily began using Telex. In 1934 AT&T established a network of 10,000 Telex subscribers in the United States with Telex. Such adoption expanded worldwide (Beauchamp, 2001). Meanwhile, prevailing telegram services, such as those offered by Western Union, began to integrate with Telex (Colombo, 1958).

Following the establishment of Telex, the telegram and Western Union services began to decline, if only gradually (Hochfelder, 2002). Western Union took the lead in microwave technology, which influenced much of the wireless communication technologies in use today (Rotenstein, 2006). The company was the first private organisation to carry commercial messaging traffic using such a technology and so it remained well positioned as well into the twentieth century. Still, its telecommunications arm inexorably declined due to the growth of the telephone (Hills, 2007), regulations, Telex, and blurring boundaries between communication industries (Hochfelder, 2002; McDonald, 2012).

As a result, Western Union expanded its global payment services, which began in the 1870s and grew with globalisation during the 20th century (Selbach & Lana, 2015). Western Union became the largest global payment service operator for payments between people, that is, outside of banking and correspondent banking services. True, Telex came to form the basis for global payment services between banking organisations and for correspondent banking (Scott & Zachariadis, 2012, 2013). Nonetheless, it was with telegram technology that internationally global foreign exchange transactions sped up (Garbade & Silber, 1978).

The key point here is that the global payment infrastructure extends back to the early days of telecommunication and the establishment of the Telegram. Further, the subsequent connectivity and speed proceeding telegram's telecommunication continue in today's global payment infrastructure with internet protocols, modem technologies, and personal computing (Beauchamp, 2001). However, before we turn to these recent digital technologies, we need to examine further cooperation among central banks, which is also part of the global payment infrastructure.

Central Banking Cooperation

Global payment infrastructure includes and extends to central banking cooperation. As Wisselbank, or the Amsterdam Exchange Bank, illustrates beginning in 1609, central banking

played a key role in stabilising global currency exchange — which of course demands the cooperation of various banks. In the words of Toniolo and Clement (2005, p. 2), "central banks operate in a world lager than their domestic sphere… Their viewpoint therefore must necessarily face outwards as well as inwards." Consequently, cooperation between central banks and their involvement in global payment infrastructure has continued since the 1600s. However, central banking cooperation and its role in global payment infrastructure became more prominent following the rise of correspondent banking and telecommunication. In 1930, such collaboration materialised with the establishment of today's oldest global organisation, the Bank for International Settlement.

Broadly speaking, central banking cooperation is characterised as informal or formal (Toniolo & Clement, 2005). Formal cooperation means central banks agree on ad hoc decisions to maintain stability internationally. For example, by lending gold reserves to other central banks during World War One, formal cooperation maintained global exchange standards and the predictable transport of goods across borders in crises. On the other hand, informal cooperation means central banks autonomously adhere to the rules of the game, facilitating global stability. For example, during the early 1800s, there was informal cooperation with three types of monetary standards worldwide (Toniolo & Clement, 2005). First, the United Kingdom, its colonies, and Portugal followed a gold standard, which converted paper money into gold at a price defined by Sir Isaac Newton in 1717. Second, the German states, the Habsburg Empire, Scandinavian countries, the Netherlands, Mexico, China, India, Japan, and most of the remaining parts of Asia followed a silver standard. The third group included France, Belgium, Switzerland, Italy, and the United States, which adopted a bimetallic standard, meaning paper money could be converted to gold or silver, and there was a fixed rate between both metals.

Central banking cooperation took many shapes prior to the establishment of the Bank for International Settlement. Due to the acceleration of international exchange and the instability of silver prices, gold became the global exchange standard by the 1860s, partly due to the financial influence of the United Kingdom. This classical gold standard provided global financial liquidity and stability and enhanced the global transport of products and services. The period from roughly the American Civil War and World War One is often referred to as the first era of globalisation (Toniolo & Clement, 2005) and sometimes the golden era of capitalism. In 1914, gold convertibility was suspended during the war. A floating exchange rate, meaning that exchange rates were volatile with no fixed prices, emerged. Some countries pegged their different currencies, keeping defined exchange prices, to maintain exchange stability. The war made

financial cooperation unavoidable, and several bilateral agreements regarding banking were signed. The United Kingdom lent heavily to France, Belgium, and Italy, and the United States (which joined the war in 1917) offered its lending support when the United Kingdom's resources ran low. After the war, discussions to restore the gold standard went nowhere, with many central banks instead focused on their individual country's recovery (Toniolo & Clement, 2005).

Instead, discussions for an international bank restarted after the First World War. Montagu Norman, a banker who served as governor of the Bank of England from 1920 to 1944, outlined central banking principles that would influence the formation of such an organisation. In 1921, Norman issued a central bank manifesto stressing independence from national governments, separation from commercial banks, banking supervision, and cooperation. In this case, cooperation meant exchanging confidential information and not-for-profit actions that would maintain global financial stability (Toniolo & Clement, 2005). Other ideas for a global bank included an international currency backed by gold and used for emergency lending, a global clearing institution, international gold certificates, and an international bank note. During the early 1900s, these ideas further found an important advocate in Luigi Luzzatti, a political figure, who argued that lending among authorities should become the norm and that politics during crises should not come in the way of cooperation (Toniolo & Clement, 2005).

These ideas — and the general increase in banking cooperation — were the backdrop to the establishment of the Bank for International Settlement (Pugsley, 1950; Toniolo & Clement, 2005). Its consolidation from 1930 to 1973 aimed at managing global gold standards, restoring global trade in Europe following World War Two (Pugsley, 1950), and assisting in the Bretton Woods System (Pugsley, 1950; Toniolo & Clement, 2005). The latter system began throughout the end of World War Two and required currencies to link to the price of gold. Since this system's end in the 1970s, the Bank of International Settlement's role has become more prominent in the global payment infrastructure (Lessambo, 2015).

Today, the Bank for International Settlement has its headquarters in Switzerland, which has no jurisdiction over its premises. The bank's views of cooperation resemble those of Norman and Luzzati, and its primary objective is the "maintenance of a stable system of international payments" (Toniolo & Clement, 2005, p. 3). The bank serves as a forum for understanding global payment infrastructure and as a bank for central banks. It is governed by 55 central bank members, a board of directors formed by central bank governors, and its management, which includes a chief executive officer, senior officials, and representatives (Lessambo, 2015). Further, the bank is comprised of three departments and six committees. First, the Banking Department carries out

banking transactions on behalf of central bank customers. Second, the Monetary and Economic Department conducts economic research and produces the organisation's annual report. Third, the General Secretariat provides administrative support. Lastly, the six committees monitor, research, and serve as a forum for global payment infrastructure changes and discussions.

Central banking cooperation stays crucial to today's global payment structure. But of course, this infrastructure does not end here. *How* individuals make payments also matters and further extends the global payment infrastructure. We thus turn to payment cards, which continue from paper payment instruments as telecommunications modernised.

Payment Cards

Payment cards took form in the middle of the twentieth century and extended globally during the 1970s with Visa and Mastercard (Bátiz-Lazo, 2012; Maixé-Altés, 2020; Olney, 1991; Stearns, 2007). With telecommunication, payment instruments began becoming digital, which arguably demanded a separation between authentication, the process of validating one's identity, and the instrument (Stearns, 2007). Such separation took place with payment cards. As the reader almost surely knows, cheques, novel forms of bills of exchange, were the standard payment instrument during the 1900s. These instruments include the authentication of its issuer with a signature, which subsequently facilitates its exchange for funds.

During the early 1900s, cheques were discounted unless presented in person. Banks created cooperative clearinghouses, organisations that would receive messengers from different banks, to manage cheque deposits more efficiently. Correspondent banking relationships also were used to manage the clearing of cheques to avoid the costly movements of gold and notes within the United States. These practices preceded the 1913 creation of the Federal Reserve System in the United States, which established a national clearing system for banks using telecommunication technologies (Stearns, 2007).

In 1914, Western Union became among the first card issuing firms, meaning it would issue charge cards to its recurring customers(Stearns, 2007). These nascent credit cards were used to identify the billing account and the signature to authenticate cardholders. They functioned as credit instruments for Western Union's customers by allowing the organisation to efficiently charge their accounts. In the 1930s, this model was extended with multiple organisations

associating in cooperatives that would enable cardholders to use their cards at various merchants — which are the organisations people pay to (Stearns, 2007).

The second wave of payment card instruments took place after the Second World War. Occurring especially in the travel and entertainment industry, this wave extended the payment card beyond a single county. During the 1950s, the merchant was no longer a card issuer and became only the accepting organisation of the payment transaction. In contrast, card issuers became an organisation receiving payments, offering merchant accounts, and making a profit by discounting payments to merchants (Stearns, 2007). This system dates to the establishment of the Diners Club in 1949. Diners Club issued a payment card that its customers could use internationally and across many different merchants that were part of the club. The charge card became a prestigious payment instrument, primarily used by businesspeople, and it came with a booklet listing affiliated merchants which eventually grew too long and was separated (Stearns, 2007). Only selective merchants and people qualified to become part of the club and its range of global travel and entertainment payment options. Diners' success came with further competition in the industry with similar approaches from American Express and Hilton's Carte Blanche card (Stearns, 2007).

The third wave of the payment card instruments expansion came with the global growth of Visa and Mastercard, which extended the payment card to a broader audience. This wave came with further standardisation and changes in cards, which today are highly used for global payments and other digital payment instruments. The predecessor of Visa was BankAmericard, a credit card issuing program by the Bank of America aimed at middle-class people. Bank of America had the resources to extend the payment card to a broader audience. During the late 1950s, the bank did so with its card program by licensing its system and establishing an association with other banks. Even though single banks began offering card services, National BankAmericard Inc, the independent organisation owned by its members following the growth of the Bank of America card program, and its competitor association, Interbank, grew card services and standards globally (Stearns, 2007). Respectively, these two associations precede Visa and MasterCard.

Card instruments took further shape when computing and telecommunication extended across banking organisations. For example, the automatic teller machine (ATMs) took shape during the 1970s and 1980s, allowing for automation and online banking services through computing networks (Bátiz-Lazo, 2009). Similarly, payment cards came with developments implicating multiple global organisations and computing services (Maixé-Altés, 2020). Among the relevant card standards and practices introduced with the growth of computing were new forms

of authorisation, automation of clearing and settlement for retail payments, connections for global payment transactions, and the automation of point-of-sale transactions.

As Visa illustrates, these new standards that came with payment cards took shape as electricity and telecommunication veered into payment and money (Stearns, 2007). Nonetheless, with the expansion of payment cards came delays in authorisation and the increase of fraud became a problem. In its early days, authorisation in payment cards was a manual operation following a two-step process. First, there was a local authorisation whereby merchants would call a processing organisation, a third-party organisation serving the merchant, the card issuer, or both. Amid these difficulties, processor organisations began automating the authentication service by consolidating all cardholder data into one computer system and defining authorisation rules (Stearns, 2007). Merchants would then contact the processor organisation, and operators would input the transaction information into computing terminals, which confirmed the client's account against a list of non-authorised cards or the account's history and credit availability.

However, when cards were not affiliated with the processor organisation, further authorisation was needed between different processing organisations. An additional call or telex confirmation was sent to the card-issuing organisation to confirm the authorisation process. This extra step and delay led to the application of switching systems and connections between card processors and issuing organisations. Computer to computer and computer to terminal links were established, together with switching mechanisms, which directed the card authorisation call to the appropriate data centre. This automation not only facilitated the payment process allowing for increased speeds but also was followed by the automation of clearing and settlement between different card processors and banks. Similar connections were established between these organisations, and paper-based clearing was transformed with centralised electronic clearing (Stearns, 2007).

Indeed, computing eased the global expansion of Visa and its instruments. The Bank of America had a licensing program offered to banks abroad. Such a program grew into a global organisation that would then adopt the name Visa and be closely related to the operations of National BankAmericard Inc and Interbank (Stearns, 2007). However, Visa would follow strict governing procedures in its board members to ensure that all participants took a minority position. Adding to this set-up were further advancements in computing during the 1980s, which allowed Visa to transform into a global payment organisation and further establish payment card standards in partnerships with IBM. Technical advancements allowed for faster international transfers, which remained slow and reliant on Telex. As new computing services were established for card

payments, systems to read and write Telex messages came to facilitate international transfers, which needed connections among different time zones. A computer network was established to address foreign exchange transactions, allowing multicurrency accounts and merchants to charge percentage foreign exchange fees during their payment process (Stearns, 2007).

During this same era, card standards further progressed with the creation of point-of-sale terminals. The point-of-sale terminal, along with magnetic strips on cards, greatly standardised the payment process across merchants. The magnetic stripe is a magnetic tape attached to a plastic card and encodes binary data that can be extracted through readers, which facilitates standardisation. Thus, Visa now promoted point-of-sale terminals across its participants. And Visa was involved in developing the data standards formats encoded in magnetic stripes and in the setting of rules for using such systems (Stearns, 2007).

As the last illustration of this third wave, the payment card further transformed with the creation of debit cards — cards that banks issued to access clients' available funds through ATMs during the 1970s (Bátiz-Lazo, 2009). With controversy, Visa extended its card business to create what its leading founder, Dee Hock, envisioned as an asset card, which would convey electronic payment (Stearns, 2007). The debit card was established with hesitance as it directly accessed clients' funds. Despite early resistance from critics, however, debit cards are well-established today, and Visa processes most of its transactions with them.

Indeed, these payment card instruments further extend the global payment infrastructure. These instruments precede and are part of digital payment instruments and emerging transactional technologies, which recent histories illustrate. Before onboarding such histories, it is relevant to consider the creation of standards for global payment between banks.

Global Payment Standards

Following paper payment instruments and ledgers, central banking, correspondent banking, telecommunication, central banking cooperation, and payment cards, global payment infrastructure further extends with the establishment of global payment standards. The connectivity and speed in global payment following telecommunication technologies also came with the growth of information and global payment transactions. In turn, operational issues and a need for further standardisation in global messaging services became prominent. Against this

backdrop lies the establishment of global payment organisations for global payment standards, as is the case of the Society for Worldwide Interbank Financial Telecommunication (SWIFT).

The establishment of SWIFT, in 1973, occurred when the growth of information and global payment messages had increased complexities for banks' global payment services. Unstandardised network connections among different banks led to an increase in messaging operational risks for the global financial industry (Scott & Zachariadis, 2012). In response, the Society for Worldwide Interbank Financial Telecommunication (SWIFT) was founded in a global industry collaboration effort. As a result, SWIFT came to replace non-standardised telegram messages as an alternative to Telex and subsequently as a standard network for global interbank payment (Scott & Zachariadis, 2012).

SWIFT provides a central and standard communication channel and is run as a non-profit institution governed by its participants. In its initiation, SWIFT sought to combat the limiting capacity, free writing formats, and lack of security of global payment messages using Telex. In response to these problems, First National Citi Bank, Bank of America, Chase Manhattan in the United States, and Barclays, Lloyds, and Midland Bank in Europe had explored the creation of a private banking network. These discussions took place in the 1960s, following the envisioned messaging volume rates that state-owned postal, telephone, and telegram organisations could impose on banks. Thus, early cooperation between global banks took place with constant consultation among correspondent banks handling high volumes of transactions. European banks consortiums were set to convince 68 from the United States to join the International Message Switching Project, or MSP (Scott & Zachariadis, 2012).

Following the need for United States banks to join the project, different governance models were explored, and a cooperative model among participants was set to establish the project (Scott & Zachariadis, 2013). The cooperative format had several implications. First, founding members of SWIFT would provide start-up equity funding. Following Belgian law, the cooperative was owned and controlled by its members, who are also responsible for providing governing facilities. This cooperative status also meant that SWIFT's ownership and control were proportionate to the usage of its services (Scott & Zachariadis, 2013). The legal set up, however, followed a management structure of a board of directors and operational, financial, and organisational functions independent of its ownership structure.

As mentioned, SWIFT was born in 1973 — and more specifically in Brussels. Its membership was 270 banks from 15 countries, and its messaging network was running by 1975 (Scott & Zachariadis, 2013). However, SWIFT's reach significantly increased with the creation

of another proprietary messaging network run by a subsidiary of The First National City Bank. This standard and network competitor, named Machine Readable Telegraphic Input or MARTI, demanded its participants use only its service and private network (Scott & Zachariadis, 2013). The result was the onboarding of the global banking community on SWIFT's network, which remained open to multiple correspondent banking relationships run by multiple banks.

SWIFT involves different user groups with different rights. As of 2013, these included supervised financial institutions, non-supervised entities, closed groups, and cooperate entities (Scott & Zachariadis, 2013). Supervised financial institutions can send any message and have a form of ownership at SWIFT. This group is mainly formed by banks, security brokers, and investment management institutions. Non-supervised financial institutions can send any message to supervised financial institutions but cannot receive messages. Lastly, closed groups and corporate entities have access to the messaging network as defined by its administrator, a supervised financial institution.

SWIFT has come to define today's global payment messaging standards at banks, which was indeed one of its original main priorities. Messages were organised as "Messaging Types" or MT. In 1975 these followed four categories: 1) for customer transfers; 2) for bank transfers; 3) for foreign exchange; and 4) for statement messages and general queries and answers (Scott & Zachariadis, 2013). The standard followed a proprietary messaging language, "FIN." This syntax was formed by five blocks and used codes to refer to specific fields. For example, the field for the transaction reference was the syntax ":20:" (Scott & Zachariadis, 2013). Furthermore, during the 1980s, SWIFT came to take part in the creation of the Business Identifier Code, or BIC, in close collaboration with its members and the International Association for Standardisation, ISO. This standardisation continued with discussions around the use of eXtensible Markup Language (XML) standards, which later centred on the creation of ISO 20022 and a change from MT formats based on further flexibility and capacity of data creation (Scott & Zachariadis, 2013).

SWIFT serves as a standard for payment messaging services, but its impacts extend beyond global payment messaging (Scott & Zachariadis, 2010; Scott et al., 2017; Scott & Zachariadis, 2012; Scott & Zachariadis, 2013). For example, SWIFT's standardised communication network allowed interbank payments to scale (Scott et al., 2017; Scott & Zachariadis, 2012). Further, by serving as a central communication channel, SWIFT came to be implicated in the long-term improvement of banks' profitability, with smaller banks benefiting the most (Scott et al., 2017).

Most recently, standardisation between banks has continued with the creation of regulatory standards and settlement organisations. These organisations include the Financial Action Task Force, the Wolfsberg group, and the CLS bank. The Financial Action Task Force, FATF, is an organisation established in 1989 to regulate global payment, created as an initiative of the G7 (an inter-governmental forum of some of the wealthiest nations). Following concerns about money laundry and financial terrorism, the G7 formed the FATF to set global regulatory standards, assess compliance, and identify different responses to counter money laundry and financial terrorism (Aamo, 2017). Today's task force includes over 35 jurisdictions, and more than 180 have endorsed the principles and standards created by the task force (Aamo, 2017). Moreover, the task force and standards are commonly mentioned in documents and reflections of reports at the Bank for International Settlement. Of relevance for the regulatory standards followed today is the task force's emphasis on risk-based approaches. This approach means that regulation is (at least should be) proportionate to the risk incurred. Further, there is a focus on beneficial ownership, meaning that global payment organisations should conduct due diligence to know their customers and understand where funds come from.

These regulatory standards, and continued cooperation among global banks, led to the establishment of the Wolfsberg Group in 1999. This group seeks to further standardise anti–money laundering and know-your-customer practices. Following the monitoring of cash transactions in the United States with the Bank Secrecy Act in 1970 and the Financial Action Task Force principles, the private sector was in need of further standardisation in its due diligence practices. The Wolfsberg group formed through a set of practices whereby participant banks, today thirteen of the largest global banks, would share their due diligence standards and agree on new ones (Pieth & Aiolfi, 2003). Among these standards came the support of lists for high-risk sectors and industries and reporting of uncommon global payment channels (Aiolfi & Bauer, 2012).

The final illustration of standards for the settlement of global payment transactions concerns foreign exchange. Standardisation in this arena came with the CLS Bank, which stands for continuous linked settlement. CLS bank started operating in 2002 and facilitated foreign exchange risk management by directly connecting with central banks and establishing a payment vs foreign payment exchange settlement procedure (Lindley, 2008). This has resulted in reduced waiting times for clearing foreign exchange transactions, and clients get funds paid as soon as they complete their payment. The impetus for the CLS was the foreign exchange risk incurred with correspondent banking procedures for settling high-value foreign exchange transactions.

Since its establishment, CLS bank has become the standard for handling most foreign exchange settlements by volume.

By now, it should be clear that the global payment infrastructure does not reside within any one country, organisation, person, or identity. By its systemic nature, it is global and without a delimiting end. The last section below provides final evidence.

Digital Payment Instruments and Blockchain

Most recently, global payment infrastructure includes mobile payments and new digital payment instruments, especially Bitcoin and other blockchain technologies. Since the early 2000s, mobile payment has been taking form within countries (Kazan et al., 2018), and it has recently moved well beyond the wealthy world. Given that many residents of developing nations were unbanked until mobile phones, some of these nations have actually been leading the development of mobile payment. In addition, Blockchain, Bitcoin's underlying technology, took form in 2008. These technologies serve to validate payment transactions through the distribution of ledgers and payment data creation and private and community-based global payment organisations (Giraldo-Mora, 2018; Zachariadis et al., 2019).

Digital payment instruments would not have been possible without improvements in settlement speeds within countries (Guo et al., 2015; Kazan, 2017). In the 1970s, countries began implementing real-time settlement systems, which offer services for the rapid execution of transactions between banks without batching transactions and relying on scheduled processing times during the working day. These implementations continue today across multiple regions (SWIFT, 2015). In parallel, since around 2007, telecommunication organisations have been taking part in the settlement of low-value payments in developing regions, which heavily rely on cash and have a high percentage of mobile phone use (Hanseth & Nesse, 2021; Oborn et al., 2019). Mobile devices, such as mobile phones, serve the transfer of electronic funds. This transfer implies not only a rapid confirmation but also a rapid settlement. Such is the case not only within countries (Hanseth & Nesse, 2021; Kazan et al., 2018; Oborn et al., 2019) but also across regions (Giraldo-Mora et al., 2020; Guo et al., 2015) such as Europe's Single Euro Payment Area initiatives illustrate.

Bitcoin, described as a peer-to-peer global digital payment instrument (Nakamoto, 2008), emerged in 2008. Bitcoin came as a technological solution and community-based initiative to

offer and settle digital payment transactions with the sharing and validation of payment data creation across a community. As digital payment data may be copied, there is an issue referred to as double spending by technological communities. The issue lies with the difficulty of preventing a digital token, or payment object, from being duplicated and spent more than once. This problem in payment means regulatory and intermediary organisations, such as correspondent banks, serve to keep the integrity (no change) and provenance (the origin and sequence) of digital payment data (Giraldo-Mora, 2018).

However, Bitcoin maintains this provenance through its Blockchain technologies and community (Andersen & Bogusz, 2019). Setting rules at the database transaction level (Glaser, 2017) with a community of participants (Bogusz & Morisse, 2018; Dodd, 2018) allows for integrity and provenance in payment data and this global digital payment instrument. Cryptography and public key infrastructure (PKI), broadly a shared code for referencing different token funds directly connected to a private code for authorisation, serve the validation of new data entries. Then, integrity takes place by grouping transactional data in a block-like format or batch. At the same time, a Merkle tree structure, a tree of cryptographic hashes, allows for linking and tracing payment transactions grouped in different Blocks. Finally, this database is shared across the participants of the community, and its changes are validated through a consensus process whereby a computational problem[7] is solved and then replicated across the community (Giraldo-Mora, 2018). This process results in the integrity and provenance of payment data without a single coordinating actor. In sum, the decentralised computing that began before internet protocols and cryptographic systems for securing data messages (Merkle, 1979) veered into the establishment of Bitcoin and similar global digital payment instruments.

Since Bitcoin, several other blockchain organisations and digital payment instruments have followed on the heels of Bitcoin and become part of the global payment infrastructure. General purpose computing services for the processing and validation of transactions and ledgers follow the underlying ideas of Blockchain for the establishment of what is denoted as a "decentralised autonomous organisation" (Ethereum, 2017; Wood, 2014). With the general

[7] Namely, the finding of a nonce, a random number, which makes a hash "block" containing a batch of transactions begin with a specific number of zeros or agreed characters. As this block hash is a string of characters produced by a cryptographic algorithm, it isn't easy to decipher its content with digital computing techniques. This means a unique input produces the same alphanumeric output. However, by adding a defined hash output with an encoded number of zeros, the computational issue comes as the guessing of a number, a nonce, added to the block with transactional data (Nakamoto, 2008). This makes replicating the block an easy task and changing it a tough one because it means recreating the Blockchain history, which is already shared and agreed upon.

accessibility of these programmable transactional technologies and their community organisation (Code & There, 2016) comes the creation of other "cryptocurrencies" and services for tracing the provenance of goods. There also are messaging and payment networks established under the more generic category of Distributed Ledger Technology, which follows the underlying logic of Bitcoin and Blockchain without necessarily having the same computing and consensus arrangement. This latter name commonly emphasises arrangements in the banking industry, which tend to follow established trusted legal frameworks and the regulation of participants (Rosner & Kang, 2016; Zachariadis et al., 2019).

These recent developments in global digital payment instruments are grafted onto past infrastructure (Ciborra, 2006; Kallinikos, 2006b, 2011; Shiller, 2003), as this chapter has illustrated. However, one might reasonably argue that the development of this infrastructure still comes without precedent. Indeed, calls for the study of financial technology (Gomber et al., 2018), discussions on central bank digital currency (BIS, 2018b; Sveriges Riksbank, 2018b, 2018a), and banks' involvement with digital identification (Eaton et al., 2014, 2018), and the general uncertainty on how global payment infrastructure develops lend credence to this assertion. On the other hand, it is also possible to conclude that "the further the value has to travel, the more complicated it is, the more expensive and the longer it takes," which drives attention to slow development and a long-lasting global payment infrastructure (Riksbank, 2022, p. 25).

Summary and Questioning Conclusions on Global Payment Infrastructure Development

In summary, the House of Medici, with its paper payment instruments and ledgers, underlies contemporary global payment infrastructure. Central banking and correspondent banking follow, illustrating organisations and practices for stability in foreign exchange. Telecommunication, central banking cooperation, payment cards, and global payment standards give a sense of the systemic nature of this infrastructure. Lastly, digital payment instruments and blockchain present some recent histories of global payment infrastructure.

Understanding global payment infrastructure with this bricolage of histories draws attention to an anomaly in its development. There is an unprecedented development that implies a discontinuous infrastructure because there is change taking place with multiple payment

relationships in global payment. At the same time, there is a temporally long development illustrating a continuity over time and a slow building up of global payment infrastructure. As the global payment infrastructure is highly regulated and of critical nature, and because it reaches many lives, it takes time to develop and does not simply transition from one form to another. Yes, this infrastructure also involves unprecedented changes that come without clear delimiting ends in this infrastructure. But even as new structures, such as Bitcoin and Blockchain technology, appear, old ones, such as double-entry bookkeeping and ledgers, remain central for global exchange. As the following chapter shows, unfolding this infrastructure's development also is beyond the bounds of infrastructure studies.

CHAPTER THREE

Infrastructure Development

This chapter reappraises infrastructure studies to address the development of the global payment infrastructure. It starts with a brief introduction to infrastructure. Then, it elucidates two current research streams that seek to understand infrastructure development. The first stream emphasises continuity and persistence in infrastructure development — and thus the endurance of structure. The second emphasises change and the need for an outcome to have structure or, in short, an outcome for structure. Even though their differences, tensions[8] often address infrastructure development in both streams by isolating such development and giving an overemphasis on persistence or change. As a corollary, the chapter ventures into the processual and ecological philosophical grounds of infrastructure studies to reveal movement in infrastructure development.

Before proceeding, it is worth noting that infrastructure studies encompass a wide range of fields, including Anthropology to Media Studies, History, Science and Technology Studies,

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[8] While there is no concise definition of tensions, the concept follows opposition between ends. Those ends often are delimited structurally and temporally as is the case of the two research streams in this chapter. Following this broad view of tension, the word and concept is commonly used together with the following concepts, which are present in infrastructure literature. Putnam et al. (2016, pp. 69–72) provides some guiding definitions:

- "Dualism: The existence of opposite poles, dichotomies, binary relationships"
- "Duality: Interdependence of opposites in a both/and relationship that is not mutually exclusive or antagonistic"
- "Contradiction: Bipolar opposites that are mutually exclusive and interdependent such that the opposites define and potentially negate each other"
- "Dialectics: Interdependent opposites aligned with forces that push-pull on each other like a rubber band and exist in an ongoing dynamic interplay as the poles implicate each other"
- "Paradox: Contradictions that persist over time, impose and reflect back on each other, and develop into seemingly irrational or absurd situations"

Even though reviewing these different oppositions and their intellectual streams lies outside the scope of this study, and it is already done elsewhere (Putnam et al., 2016; Smith et al., 2017), their descriptions are useful for the reader wondering about tensions as an academic discourse.

Management, Organisation Studies, and Information Systems. Needless to say, these various fields present a range of views on infrastructure. They also use divergent terminology, with terms such as information infrastructure (Ciborra & Associates, 2000), digital infrastructure (Tilson et al., 2010), large technological infrastructure (Hughes, 1987), organisation infrastructure (Leonardi, 2011), thinking infrastructure (Bowker et al., 2019), infrastructure occurrence (Star & Ruhleder, 1996), and infrastructure world (Reimers et al., 2022), to name a few. Further, scholars approach infrastructure as both a noun and a verb, infrastructuring, which demands confronting a range of epistemological and ontological assumptions and issues. To handle such complexity, this chapter foregrounds sociotechnical emphases on infrastructure (Sarker et al., 2019). In accord, the chapter uses the term human and technological infrastructure, or, in short, infrastructure.

Infrastructure

When one commonly thinks of infrastructure, an underlying form or object comes to mind. For example, pipes underlie the movement of water, cables underlie the movement of electricity (Hughes, 1983), roads underlie the movement of cars, railroads underlie the movement of trains, and, more generally, physical spaces underlie the movement of people (Fisch, 2013). Similarly, pipes, cables, roads, railroads, and physical spaces are related to action. Drinking water, reading at night, driving home, travelling to a new place, and meeting people are some examples. In these latter instances, infrastructure is in practice, meaning when people do activities. Considering these understandings, concepts explaining infrastructure often resonate with the metaphor network, which broadly defines infrastructure as "things and also the relation between things" (Larkin, 2013, p. 329).

For example, the characterisations of infrastructure as *Installed Based* (Hanseth & Lyytinen, 2010) draws inspiration from Actor Network Theory and the influence of standards for future infrastructure changes (Hanseth, 2000; Monteiro, 2000). As an installed base, infrastructure entails multiple actors' interactions, both human and material, or broadly people and substances. There is an infrastructure configuration constantly growing in complexity as more actors emerge over time (Hanseth et al., 2006, 1996; Hanseth & Monteiro, 1997). In this sense, the concept of installed base aims to convey heterogeneity and action in order — in infrastructure (Hanseth & Lyytinen, 2010).

With some affinity to the installed base background, recent infrastructure literature centres on integration and blurring firm boundaries through the development of digital technologies (Yoo et al., 2010). Following this phenomenon, infrastructure entails *Interconnecting Systems Collectives* (Henfridsson & Bygstad, 2013). This conceptualisation argues it is constraining to understand digital phenomena, and digital infrastructure, through siloed systems. Conversely, as interconnecting systems collective, infrastructure is the fundamental technologies and organisational structures that support an organisation's creation, evolution, and change because infrastructure underlies industry and societal functions (Tilson et al., 2010). In other words, infrastructure is beyond organisational boundaries, as has long been emphasised (Ciborra & Associates, 2000; Star & Ruhleder, 1996). Infrastructure is then characterised in relation to its development with technology and subsequent implications for organisations and society. For example, the creation of platforms as new forms of organising (Ciborra, 1996). Ultimately, these views on infrastructure resonate with the network metaphor with an emphasis on the contingent and connecting nature of society and organisation with what is termed digital infrastructure (Yoo et al., 2010, 2012; Zammuto et al., 2007).

Following infrastructure's relation with societal and organisation functions are descriptions of its *Embeddedness*. The term conveys how infrastructures sink and merge with other infrastructures in social practices (Fürstenau et al., 2019; Vaast & Walsham, 2009). In this process, not everything becomes or is infrastructure. People's day-to-day actions take place with infrastructure embedded in a network of action. Infrastructures become part of such a network and embed with other infrastructures. In such a process, practices change. For example, the practices of science and knowledge creation for a global community of geneticists were affected by the unsuccessful development of a global knowledge management system (Star & Ruhleder, 1996). Knowledge gaps between the practice of geneticists and engineers, for instance, led to tensions between knowledge levels. In accord, infrastructure is and becomes embedded in practice. Embeddedness is one of the qualities for understanding the phenomena in practice with ethnographic and case studies (Bowker, 1996; Fürstenau et al., 2019; Star & Ruhleder, 1996; Vaast & Walsham, 2009).

Such a view of infrastructure in practice is similar to the notion of infrastructural inversion (Bowker, 1994). Bowker (1994) emphasises how changes in work practices are with changes in infrastructure leading to an infrastructural inversion. For example, following the works of Charles Babbage, Bowker (1994, p. 238) argues that the creation of a printing press "marked the capture of the past" while calculation "marked the determination of the future," which leads to an

infrastructural inversion where a new reality, the information mythology, takes form. There is an inversion from actors' doings to the practices that define actors and their reality. In these studies, the questioning shift from what is an infrastructure to when is an infrastructure, following its study in practice (Start & Ruhledger, 1996). Considering such background, Start and Ruhledger (1996) introduce other qualities along embeddedness, which are:

- *Transparency in use.* Infrastructure facilitates tasks and is not reinvented or reassembled every time it supports those tasks.
- *Reach or scope in space and/or time*. Infrastructure reaches beyond a single event or one-site practice.
- *Learned as part of membership*. Infrastructure is taken for granted once it is learned, and new participants learn it and familiarise themselves with it as they become part of a community of practice.
- *Links with conventions of practice*. Infrastructure shapes and is shaped by conventions of a community of practice, just as QWERTY is shaped by and shapes generations of typists and computer designers.
- *Embodiment of standards*. Infrastructure plugs into other infrastructure and tools in a standardised manner, which crystalises infrastructure as it changes in scope and through conflicting conventions.
- *Built on an installed base*. Infrastructure wrestles with the inertia of an installed base of users requiring flexibility for backward compatibility as well as new developments.
- *Becomes visible upon breakdown*. Infrastructure is invisible when it works and becomes visible when it breaks.

Complementing the understanding of infrastructure as being in practice is the concept of *Imbrication.* By resonating with the network metaphor, imbrication illustrates overlapping infrastructures, which are together and changing with a larger whole (Star, 2002). However, the concept also differentiates by emphasising the infrastructure as enduring and conditioning present and future infrastructure. For example, imbrication foregrounds the process by which risk mitigation techniques and digital technologies merge into each other in the financial sector (Ciborra, 2006). The line between the process of accounting for risk and its technology blurs; they imbricate. When imbricated, infrastructure endures before its encounter with human actors, leading to constraining perceptions. This perception leads humans to intentionally respond to technology, therefore driving new imbrications and infrastructure (Leonardi, 2011).

Imbrication resembles the conceptualisation of infrastructure as *Gestell*, which precedes ideas of imbrication (Ciborra, 2006; Ciborra & Hanseth, 1998). However, Gestell tends to incorporate the human and technological aspects of infrastructure more evenly than imbrication. Broadly, the concept conveys infrastructure in "the reunion of the placing, arranging, regulating, ordering" (Ciborra & Hanseth, 1998, p. 318). Or in different words, infrastructure is self-reinforcing ordering processes. Following this background, infrastructure is continuously gathering and ordering human and material activity. For example, the processes that order natural and human resources to create electricity and light self-feed with light consumption. At the same time, infrastructure is instrumental for transformation, as water currents transform into electricity with hydroelectricity processes.

The network metaphor does not intuitively resemble the processual understanding of Gestell. However, in developing the understanding of Gestell, Heidegger also uses the word Ge-wirk in a preceding lecture on "Science and Reflection." Levitt translates the term as "interacting network" and clarifies in a footnote that in "isolating the prefix ge- in the ordinary noun Gewirk (web, texture, weaving), Heidegger would have us hear… the more fundamental meaning of a gathering of that which works and is worked" (Heidegger, 1977, p. 168).

Table 1. Infrastructure Concepts Resonating with the Metaphor Network

Concept	Description	Illustrative Reference
Installed Based	An already present, shared, unbounded, heterogeneous, and evolving sociotechnical system	Hanseth et al. (1996), Star and Ruhleder (1996), Hanseth and Lyytinen (2010)
Interconnecting Systems Collectives	The constant integration of old and new systems	Henfridsson and Bygstad (2013a), Tilson et al. (2010)
Embeddedness	Depth of relational structure in work practices	Star and Ruhleder (1996), Vaast et al. (2009) Fürstenau et al. (2019),
Imbrication	Overlapping, interlocking patterns of structures or representations, which are different, active, and interdependent	Star (2002), Ciborra (2006), Leonardi (2011)
Gestell	Ordering process	Ciborra and Hanseth (1998), Ciborra (2006), Ciborra (2007)

As Table 1 summarises, what the metaphor of network and these resonating concepts illustrate is infrastructure does not reside and changes as a bounded thing. Infrastructure is not just a system or a part with a definite identity. Infrastructure is neither controlled (Ciborra & Associates, 2000) nor a "thing stripped of use" (Star & Ruhleder, 1996, p. 113). In light of such background, emerging research arguably rejects the idea infrastructure is outside one's world. Giving an individual emphasis, Reimers et al. (2022) build from the early works of Heidegger and his understanding of equipment to introduce infrastructure as a relationship between a person and their world. The authors illustrate the process of bringing technologies and practices into one's world, infrastructuring, which makes one's world, infrastructure, change with breakdowns and discontinuities. Thus, infrastructure is a home for a person and lies with one's activities and being in the world.

In summary, the metaphor of network brings up understandings of infrastructure that include structure — a stable form — with activity, which is the different practices people do. Considering this background, this study approaches infrastructure as sociotechnical (Sarker et al., 2019), meaning infrastructure is both human and technological and therefore conveys both activity and structure.

Infrastructure Development Streams

A sociotechnical perspective on infrastructure raises complexities in understanding its development. Such complexities, however, are addressed by two prominent scholarly streams in infrastructure studies, which result from a genealogical analysis of the literature, as Appendix A details. One stream emphasises the persistence of infrastructure because structure endures and is hard to change, as one would intuitively think of infrastructure. Thus, acknowledging the endurance of structure implies a sequential development, meaning past infrastructure conditions the current and future infrastructure development.

The second stream attends and gives primacy to change in infrastructure development, meaning structure follows frequent change and is hard to define. There is discontinuity, a difference in infrastructure. As one would intuitively think when facing an infrastructure breaking down. In light of change, this second stream follows pragmatist grounds to address infrastructure in occasions with the guiding question, "When is an infrastructure?" Thus, these understandings give primacy to relationships, constant change, and activity for unfolding infrastructure

development, following the adverb when. There needs to be an outcome, a situated happening that occurs in practice, for structure. Infrastructure becomes a present matter— an experienced occasion — because it is relational and emergent in practice. Amid this background comes the conceptualisation of infrastructuring to explain the constant change, activity, human intention and work in creating infrastructure.

Perspectives Following Endurance of Structure

In the first research stream, infrastructure is a structure that endures and precedes activity. Thus, infrastructure development takes place through lasting structure conditioning present and future ones. In other words, infrastructure "does not have to be reinvented each time or reassembled for each task" (Star & Ruhleder, 1996, p. 113). Instead, there is some projection of the past on the present and future structure, with the persistence of acquired characteristics in a changing environment or context (Hughes, 1987). A typical illustration of this finding in infrastructure development is standards such as QWERTY, which endure over time (Callon, 1990; Star, 1990).

Nevertheless, this perspective acknowledges that infrastructure development is not linear, as it entails various relationships among structures. Infrastructure development trajectories drift (Ciborra, 1996; Ciborra & Associates, 2000; Oborn et al., 2019), and there is complexity (Hanseth & Lyytinen, 2010) with no single actor in control. Furthermore, as new structures appear and connect to past structures, tensions emerge in the form of conflict and opposition. For framing such tensions, Tilson et al. (2010) outline the paradoxical nature of infrastructure development where stability and change persist. Similarly, Hanseth et al. (1996) argue for infrastructure development through a tension between standardisation and flexibility, which explains the evolution of structure based on growth over time (Henfridsson & Bygstad, 2013; Kostis et al., 2022).

In other words, as much as infrastructure development follows a trajectory, new structures in local contexts trigger improvisation and ad hoc fixes (Ciborra et al., 2001; Orlikowski, 1996). Consequently, there are persisting efforts to understand trajectory drifts, nested evolutionary paths and shifting structural configurations following tensions in infrastructure development (Ciborra & Associates, 2000; Hanseth & Modol, 2021; Henfridsson & Bygstad, 2013; Tilson et al., 2010). Of relevance is this stream's attention to architecture, institutions, and functions.

An architectural emphasis addresses the configuration of different structures, which implies stability and complexity over time (Bar, 2001; Hanseth, 2000; Jensen et al., 2017; Yoo et

al., 2010). As new structures and requirements become part of existing structures, configurations shift, bringing up periods of disorder and self-organised order in infrastructure development. In light of complexity, modularity is often a way to understand infrastructure development and manage the tension between standardisation, keeping prevailing structure, and flexibility, including new structure. Broadly, modularisation implies decomposability and black boxing, meaning "only the interface (the outside) of the box matters" (Hanseth et al., 1996, p. 416). Therefore, subsystems appear, leading to an ever-growing and complex infrastructure development (Braa et al., 2007; Simon, 2002).

Through this complex infrastructure development, there is an evolution and transition in structural configurations over time. Although not centred on infrastructure per se, Geels (2002) onboards on a historical explanation of the technological transition from sailing ships to steamships. The author argues for a transition and reconfiguration of this infrastructure through mechanisms that explain the emergence of new structures waving into existing ones. With an explicit emphasis on infrastructure, Henfridsson and Bygstad (2013a) drive a similar argument. The authors study the growth of the Norwegian airline to understand infrastructure evolution with three mechanisms associated with growth and complexity. These are innovation through technical malleability, adoption through more services, and scaling through more partners. In surveying forty-one other cases, the authors find equifinality — multiple mechanism configurations for the same evolutionary structure — and nested evolutionary paths.

With a similar foundation*, an institutional emphasis* underscores the role of institutions in structures forming infrastructure, which underlie persisting behaviour over time. In other words, structure develops through established rules, norms, and practices governing behaviour (DiMaggio & Powell, 1983; Scott, 1995). For example, there are conventions underlying the consistent use of QWERTY with typists' training and designers' applications (Star & Ruhleder, 1996). Thus, QWERTY, as an example of structure, carries multiple institutional logics. These logics are the "interpenetration of the symbolic and material aspects of institutions" and illustrate the rationalities of actors underlying rules, norms, and practices in accordance with a specific institution (Friedland & Alford, 1991; Thornton et al., 2012, p. 5). In other words, different institutional orders (e.g., markets) have different material categories (e.g., cash transactions), from which different logics emerge and drive different rationalities (e.g., payment, contract).

Infrastructure development takes place through conflicts and relationships between enduring logics that structures carry over time, giving a past conditioning. There are power dynamics where the rationality of subjects lies together with existing political interests that

structures carry, which endure and subjugate others over time (Avgerou & McGrath, 2007). Inside firms, enterprise systems implementations as new structure, would carry logics that may resolve over time by flexible compliance if these are incongruent (Berente et al., 2016). When logics are congruent, power still plays a key role in the appropriation and development of structure in the organisation (Berente et al., 2019). Outside the organisation, the case is similar. Zorina and Dutton (2021) find how the development of internet structures in Belarus takes place through different logics, such as the market (e.g., with profit aims) and the state (e.g., with top-down governance). Over time, different relationships between existing actors while new appear, which explains how structure evolves through the complexity of coexisting logics, despite their tensions. This finding extends to the field of healthcare and emerging Blockchain systems such as Bitcoin (Bogusz & Morisse, 2018; Currie & Guah, 2007).

Lastly, there is *a functional emphasis* that also acknowledges the endurance of structure in infrastructure development. Structure conveys agency, which is the capacity to create a difference in activity leading to other structures over time in a self-referential process. For example, there are processes for functional simplification and closure (Kallinikos, 2006b) underlying financial transactions with the application of digital technologies. Financial infrastructures, therefore, develop with the constant emergence of lasting structures, which lead to others over time (Ciborra, 2006; Shiller, 2003). Cash as credit underlies the basis for the creation of other forms of credit, such as commercial bank money, which serves for other forms of credit, such as retail payment services, and so on. In other words, self-reference underpins the endurance and development of structure, which leads to its complexity and evolution. (Ciborra & Associates, 2000; Hanseth et al., 2006; Hanseth & Modol, 2021).

In order to unpack this infrastructure development following the application of digital technologies and its argued change implications, studies attend to materiality and argue for the imbrication of structures (Ciborra, 2006; Kallinikos et al., 2013; Star, 2002). Rather than tensions in infrastructure development, there is a sequencing following human responses to agentic structures. For example, a perception of constraint in the development of a car crashing simulation structure leads to the intention of a change in technology structure. In contrast, the perception of affordance leads to the intention to change the routine structure (Leonardi, 2011).

Table 2. Three Infrastructure Development Emphases Following Endurance of Structure				
Emphasis[9]	**Description**	**Endurance as**	**Example**	**Illustrative References**
Architectural	The structural configuration and change of infrastructure	Part	Payment infrastructure is formed by Central Banks' systems, the set of subsystems supported by Banks, and connecting networks such as SWIFT	Braa et al. (2007), Yoo et al. (2010), Henfridsson and Bygstad (2013), Hanseth et al. (1996), Geels (2002)
Institutional	The norms and politics that form and change infrastructure	Institution	Payment infrastructure carries logics conveying knowledge, rules, and politics as is the case with know-your-customer regulations	Avgerou and McGrath (2007), Bogusz and Morisse (2018), Currie and Guah (2007), Zorina and Dutton (2021)
Functional	The simplification of reality enabled and changed by infrastructure	Self-reference	Payment infrastructure simplifies transactions through cash instruments, which leads to further transactions and instruments	Kallinikos (2006b, 2006a), Kallinikos et al. (2013), Leonardi (2011), Ciborra (2006), Hanseth et al. (2006)

[9] These areas are not so clearly cut as Table 2 summarises. For instance, Kallinikos (2006b) outlines the institutional consequences of infrastructure development following functional self-referential processes, which also revisits prevailing understandings of the concept and metaphor Network.

Accordingly, these studies on infrastructure development inquiry into "how activities in the past condition (as opposed to cause) future human-material sequencing." Because "the interweaving of human and material agencies produces routines and technologies [structures][10] that are regularly used by organizational members, we can say that past human-material imbrications influence how human and material agencies will be imbricated in the here-and-now" (Leonardi, 2011, p. 152). As Table 2 illustrates, structure endures and precedes activity.

Perspectives Following Outcome for Structure

Differently, in a second research stream on infrastructure development, change and activity come first. Infrastructure as a structure is when there are changes and breakdowns, which implies there is no past structure to refer to because infrastructure is different. In other words, the structure is in a present occasion — a human experience that has no sequencing. Accordingly, following pragmatist backgrounds, this stream centres a situated happening that occurs in practice deviating human intention, an outcome, for structure. Following tensions, which help focus on change and breakdowns, there are present structure occasions (Pipek & Wulf, 2009; Ribes & Finholt, 2009; Vaast & Walsham, 2009; Venters et al., 2014). Infrastructure development, therefore, is situated,[11] within a specific context characterised by present material and social circumstances, rather than pre-conditioned.

Following this rationale, structure is when a changing nightmare for one, which is stable for another, gains an identity in the occurrence of an outcome. In such an occasion, structure is "both engine and barrier for change; both customisable and rigid; both inside and outside" (Star & Ruhleder, 1996, p. 111). It is constantly in the making, changing and being different, as a perpetuum mobile — infrastructuring (Bowker & Star, 1999; Pipek & Wulf, 2009). Thus, these infrastructure development perspectives attend to tensions emphasising boundaries, dualities, and currents of change, where structure takes place if momentarily following an outcome.

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[10] This clarification is made by author of this thesis.

[11] The term situated aims to move away from abstract and pre-scripted action, such as planning. It "underscores the view that every course of action depends in essential ways on its material and social circumstances. Rather than attempt to abstract action away from its circumstances and represent it as a rational plan, the approach is to study how people use their circumstances to achieve intelligent action. Rather than build a theory of action out of a theory of plans, the aim is to investigate how people produce and find evidence for plans in the course of situated action. More generally, rather than subsume the details of action under the study of plans, plans are subsumed by the larger problem of situated action" (Suchman, 2007, p. 70).

Following outcomes, *boundaries come to the foreground.* When an outcome occurs, such as the completion of a payment or the emergence of a new payment category, boundaries take form and drive inclusions and exclusions (Bowker, 1996; Star, 1990). Therefore, the creation of structure is characterised by ongoing negotiations and work, leading to unprecedented outcomes. Star and Ruhleder (1996), for example, find that tensions between levels of knowledge of a global scientific community of biologists and of the enginees of a new sharing system led to the unsuccessful implementation of such a system. For instance, there is an opposition between having a free and flexible information-sharing structure for biologists, whose community is characterised by collaboration, and the rigid listing structure suggested by engineers in the new system. This tension, among others, between levels of knowledge resulted in the abandonment of the system's development, with biologists turning to alternative communication channels via the still-emerging internet. Similarly, Ribes and Polk's (2014) study of The Multicenter AIDs Cohort Study (MACs) illustrates boundaries in the structure underlying the investigation of HIV. In their conclusion for understanding structure and its change, the authors outline the process of doing infrastructure through flexibility in relation to technoscientific change (e.g., change in the research object AIDs), sociotechnical change (e.g., data sharing techniques), and institutional change (e.g., regulations). A result that again drives attention to ongoing negotiations and the creation of inclusions and exclusions resulting from boundaries in outcomes.

In a different approach, *outcomes also bring up dualities.* When it takes place, structure is both engine and barrier for change, enabling and constraining, and stable and changing, a duality. Aiming to understand the long-term development of infrastructure, Ribes and Finholt (2009) and Venters et al. (2014) illustrate how such development takes place in situ. Following tensions, the authors bring up structure with dualities as a both/and result, which includes different outcomes. An illustration is infrastructures for environmental projects taking place through tensions, for example, between today's requirements and the demands of tomorrow's uses (Ribes & Finholt, 2009). To account for both outcomes, Ribes and Finholt (2009) build from the concept of the long now, which follows discussions of The Millenium Clock. A design for a clock to work now and last for one thousand years; however, "between then and now, the clock needs to be built, wound, maintained, and housed" (Ribes & Finholt, 2009, p. 393). Structure occurs with such duality following an inclusive outcome (Rolland & Monteiro, 2002). With some affinity, Venters et al. (2014) illustrate tensions following material inertia from past and projected developments in the present. For example, infrastructuring work and coordination for the development of a computing grid by the CERN particle physics community drive attention to the ongoing sustainable

development of such infrastructure to include various outcomes. From a spatial perspective, Vaast and Walsham (2009) use the concept of local universality to foreground how a structure is both applicable in local contexts and globally across contexts. In sum, outcomes drive attention to dualities in structure, which implies the inclusiveness of multiple possible outcomes in a both/and form requiring constant infrastructuring work (Aanestad et al., 2014).

Lastly, having *an outcome for structure also brings attention to currents and their shifts.* When structure takes place in a present occasion, there are discontinuities to what otherwise would be a straight-line infrastructure development current. Following tensions, outcomes bring up structure, which leads to discontinuities and a different infrastructure development. From a person's perspective, tensions give rise to new meaning and a raison d'être (Reimers et al., 2022) and a different wave of infrastructural development. From an industry perspective, looking at the digitalisation waves of the book industry, Scott and Orlikowski (2021) foreground tensions following exclusions in standards. As digitalisation drives infrastructural change, standards underlying the creation of physical books no longer correspond with their digital counterparts. In turn, the authors conceptualise such exclusions as a digital undertow to illustrate the historical shifts that follow structural outcomes underlying new infrastructural developments for the reconceptualisation of standards and their role in the book industry. With some similarities, Oborn et al. (2019) study the expansion of a UK money payment service provider to Kenya. The authors find tensions between local trajectories and the expanding payment service provider, which lead to different dynamics and unintended developments. As Table 3 exemplifies, in this second research stream, there is an outcome for a structure occasion — a human experience that has no sequencing but is instead present and different.

Table 3. Three Infrastructure Development Emphases Following Outcome for Structure				
Emphasis[12]	**Description**	**Structure when**	**Example**	**Illustrative References**
Boundaries	The inclusions and exclusions following outcomes	Demarcation takes place	When a global payment is not paid out because the payee is unable, physically, to pick up a cash payment	Star and Ruhleder (1996), Star (1990), Bowker (1996), Ribes and Polk (2014)
Duality	The relational constitution of outcomes	Inclusiveness is achieved	When a global payment service is specific enough to include cash home delivery services (e.g., Dominican Republic) and global enough to connect with other services in different countries	Vaast and Walsham (2009), Venters et al. (2014), Ribes and Finholt (2009), Pipek and Wulf (2009), Rolland and Monteiro (2002)
Currents	The trajectory shifts by outcomes	Development discontinues	When the development trajectory of global payment services changes after a new standard or regulation, which drives opposition and leads to a new trajectory	Oborn et al. (2019), Scott and Orlikowski (2021), Reimers et al. (2022)

[12] As with Table 2, illustrative references handle more than one emphasis. For instance, while Star and Ruhleder (1996) also foreground dualities and the need for inclusiveness, Scott and Orlikowski (2021) foreground the demarcation of boundaries and their subsequent processes.

Infrastructure Development Streams Disregard Movement

While these two research streams on infrastructure have produced inspiring work, they lack the breadth to address the development of the global payment infrastructure. Specifically, these streams tend to isolate infrastructure development through tensions, which as opposition and constraint, overemphasise persistence and change and disregard movement. Such isolation of development and overemphasis takes place in two ways:

1. The endurance of structure stream addresses infrastructure development through tensions between structures to emphasise persistence as the *conditioning of past on present and future* infrastructure. The issue of this theoretical approach is the isolation of infrastructure development through an *enduring structure staying still* before it encounters a human activity or a new appearing structure.
2. The outcome for structure stream addresses infrastructure development through tensions to foreground change with a different structure that follows the *present conditioning* of activity taking place with multiple infrastructural relationships. The issue with such an approach is the isolation of infrastructure development through *discontinuous situated structure occasions*.

Thus, as opposition and constraint, tensions bring up stasis based on a stable and arguably abstract form, an end. Such isolation in infrastructure development recreates the anomaly of continuity in global payment infrastructure, leaving its development unaddressed. For example, following the endurance of structure, continuity means the persistence of structure over time. Often following critical realist assumptions (Bhaskar, 1975), infrastructure development has a chronology (Archer, 1995; Faulkner & Runde, 2019; Mutch, 2010). There is a temporal difference (Giraldo-Mora et al., 2019) that theoretically allows structures to be apart and stable before interaction, which drive tensions, activity, and change (Geels, 2002; Leonardi, 2011). Accordingly, there are periods of stability and periods of change in infrastructure development characterised by momentum, path dependency, and trajectory (Hanseth, 2000; Henfridsson & Bygstad, 2013; Hughes, 1987; Mayntz & Hughes, 1988). However, by emphasising continuity with persistence in infrastructure development, there is a lack of change, which disregards movement in a structure staying still and new structures appearing without precedent.

Similarly, following an outcome for structure there is continuous change, which means structure is always different. This stream tends to follow relational and pragmatist grounds, which implies infrastructure development is in situ and on one analytical plane (Barad, 2003; Peirce, 1998). There are multiple relationships and activities whereby conditioning is present, which differently foregrounds continuity with change as a difference in form. Structure takes place occasionally when tensions as opposition and constraint resolve with the present occurrence of an outcome, which leads to the pragmatic demarcation of a structure (Bowker & Star, 1999; Orlikowski & Scott, 2019; Ribes & Finholt, 2009; Scott & Orlikowski, 2022; Venters et al., 2014). Here, there needs to be an outcome for structure; otherwise, there is nothingness. Thus, continuity comes as constant change whereby structure occurs differently in an ongoing process of infrastructuring (Bowker et al., 2019; Star & Ruhleder, 1996). However, this perspective does not account for movement either. As change is immanent, there does not seem to be continuity between structure occasions — movement — because these follow breakdowns, and continuous change makes structure always different (Reimers et al., 2022).

Without movement the change and accumulation in the development of the global payment infrastructure stays puzzling. An illustration of the limitations of disregarding movement is useful. Consider Bitcoin and its underlying technology, Blockchain, which can relate to a new structure, different from the existing global payment infrastructure (World Economic Forum, 2016). In this assumption, disregarding movement means projecting an existing stable global payment structure into the future and a new structure appearing without precedent, possibly leading to disruptive periods. However, one may question the existence of Bitcoin without the already present global payment infrastructure (e.g., foreign exchange providers). The other example is when United Kingdom banks closed bank accounts for global payment providers offering their service to Somalia. The Guardian referred to this outcome as “cutting lifelines” (Banning-Lover, 2015, p. 1). While well-intentioned, this news article relates to the implicit understanding that the global payment infrastructure occurs and develops in situ with the closing of bank accounts. Here, infrastructure development takes the form of change following infrastructural breakdowns and discontinuous situated structure occasions. Nevertheless, once again, one may question how easily such a decision was reached and how global payment providers stopped offering life-saving services.

In addition to leaving the development of the global payment infrastructure unaddressed, disregarding movement raises ethical concerns. Present arguments bring up change based on the digital transformation of the global payment infrastructure (Gomber et al., 2018) and beyond. In

light of today's epoch grounded on digital technologies, arguments favouring change tend to bring up and recreate differences and conflict, as experienced across the global payment infrastructure and as infrastructure research documents through development tensions. However, there are also calls for inclusion and sustainability that bring ethical questions to pragmatic ends tensions convey, which are especially relevant in the case of the global payment infrastructure (United Nations, 1987, 2015). Thus, there is an ethical need for a temporally elongated change devoid of a transcendental stasis that recreates conflict and exclusions in infrastructure development.

In synthesis, there is a need to reveal movement and redress the stasis and ends that come with tensions in prevailing infrastructure development research streams. Without movement, the development of the global payment infrastructure remains puzzling. As either persistence or change is primary in infrastructure development research streams, the accumulation and change of the global payment infrastructure remain out of their reach. Further, following tensions, both research streams on infrastructure development bring up ends and over-emphasise persistence and change as a difference, which raises ethical concerns because of the recreation of exclusions and the bringing up of conflict. Finally, in dissonance with the use of the term tensions, infrastructure is unbounded (Ciborra & Hanseth, 1998; Star & Ruhleder, 1996). Infrastructure development involves continuous heterogeneous processes (Hanseth & Modol, 2021; Monteiro, 2022; Scott & Orlikowski, 2021) and lies close to calls for sociotechnical theory to go beyond the ends tensions convey (Mousavi Baygi et al., 2021), which remain at the expense of movement.

Movement in Infrastructure Development

To address movement in infrastructure development, this section reappraises the processual and ecological philosophical grounds of infrastructure development streams (Ciborra, 2006; Star & Ruhleder, 1996). Specifically, this inquiry follows Martin Heidegger's understanding of technology in his later philosophy (Heidegger, 1966, 1977) and Gregory Bateson's ecology of mind (Bateson, 1972). Both scholars give different alternatives to modern understandings, broadly viewed as transcending, progressing, and giving a better definition of the world with predefined purposes. These scholars move away from ends, giving intellectual soil for addressing movement without stasis based on a stable abstract form, an end.

Accordingly, this study complements Heidegger's inward focus with Bateson's outward inclusion (Schrag, 1959). While Heidegger gives a way to address the temporality of movement,

Bateson brings such a way along with others and nature through an ecology of mind. Thus, *along ways*, foregrounds and provides an understanding of movement. To grasp each scholar's contribution to the revealing of movement, Table 4 gives a theoretical segregation, which the next sections unfold.

Table 4. Theoretical Segregation for Understanding Movement Along Ways

Assumption	Implication	Illustration
The temporal existence of movement as ***Way***	Any structure, self, or outcome is without a temporal end	Bitcoin as a global payment structure, self, or outcome is with already present ongoing global payment infrastructure. It does not appear de novo, and neither is it ending in the now
The natural coexistence of movement as ***Along***	Any structure, self, or outcome is with others, not ending with itself	Bitcoin as a global payment structure, self, or outcome is with others (e.g., country currencies, payment cards, mobile phones, computer protocols, etc.). It is not ending with itself

Way

Drawing upon Heidegger, there is a way where any structure, self, or outcome is without a temporal end. Bringing together phenomenology with existentialism, Heidegger unfolds the essence of technology, which is technological and human and akin to infrastructure. To understand this essence, Heidegger revisits technology as a tool by critiquing Aristotle's four views of causality. The result of such a quest is that technology is not mere means to an end or calculative thinking (Heidegger, 1966, 1977). Instead, technology is a way of revealing. And as a way, technology is without end; it is temporal and always existing. Technology, therefore, lies closer to the original Greek understanding of techne, which is art or craft and a way that conveys the temporal existence of movement.

To grasp how a way of revealing conveys movement, it is worth recalling Heidegger's critique of Aristotle's forms of causality, which are:

1. Causa materialis is the material out of which something is made.
2. Causa formalis is the form and shape the material enters.
3. Causa finalis is the last rite in relation to which form and matter are determined.
4. Causa efficiens is the effect that brings about something finished in a specific instant.

Following Heidegger, these forms of causality belong together. Matter is with form, both of which are with rite,[13] and therefore they effect, bring about. Yet, such bringing about, and causation itself is obscured with substances in Aristotle's forms of causality above. Instead, these causalities are coresponsible in bringing forth — revealing. Technology, as crafting and art is no means or ends, which are stasis based on stable abstract forms. Instead, by examining these four different means, Heidegger (1977, p. 12) concludes technology is "no mere means. Technology is a way of revealing." As a way of revealing, technology is the bringing about of any structure, self, or outcome beyond any ends. Because any structure, self, or outcome is with movement, a way, these are without temporal ends.

What is important in these understandings is that Heidegger's critique of Aristotle's modes of causality foregrounds a historical[14] temporal conditioning, which reveals movement. As a *way*, revealing "never comes to an end. Neither it runs off in to the indeterminate" (Heidegger, 1977, p. 16). Instead, there is an ongoing endurance that comes with the temporality and historicity characterising movement. Thus, endurance does not come as a non-moving structure. It is with movement, a way of revealing, that any structure endures. Outcomes, following the critique of causality, also lie with such movement.

The assumption of the way technology is in its essence is not nihilistic in the sense that there is nothing. Instead, all that exists is without an ending, beginning or end, or better, lies with a way of revealing, which extends backwards and forward temporally and historically. In his analysis of the essence of nihilism, Heidegger conveys that nothingness comes from a will to power, which recalls a conscious self, who is abstracted from reality and more precisely movement. Rather, in his essay "The word of Nietzsche: God is Dead," Heidegger conveys the essence of nihilism as a way, similar to technology (Heidegger, 1977, p. 53). Heidegger develops these understandings from the study of scientific knowledge, where he forms a view of the ongoing gathering for representation of what knowledge is, Ge-wrick, in scientific practice (Heidegger, 1977, p. 115,155). The conclusion is that a no-thing or a thing misses what really matters, which is the way of revealing and movement itself.

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[13] Heidegger clarifies this form of causality is often associated and misinterpreted with the words "aim" and "purpose." Yet, these words may give more meaning to Heidegger's critique and conceptualisation of technology as Gestell.

[14] The historical conditioning argued for is temporal. It is not chronological as chronology itself. For example, for Heidegger, the conditioning of technology is a way of ordering revealing.

For example, Heidegger characterises the essence of modern technology as a challenging forth, an ordering revealing. Such characterisation conveys modern technology unlocking of natural energy, its transformation, storing, distribution, and switching ever anew. All of these are ways of regulating and securing, that is, of an ordering revealing that comes with modern technology. Accordingly, modern technology implies what Heidegger refers to as a standing reserve following such ordering revealing. This standing reserve is no object, neither is it autonomous, because it is with a way of revealing following the ordering and regulating modern technology does. Technology is a way of revealing — meaning a bringing forth, unconcealing, and challenging forth, concealing of reality as human experience.

Following this background, Heidegger (1977) foregrounds his conceptualisation of Gestell to convey how technology is in its essence. Gestell refers, broadly, to the enframing way of modern technology. The concept foregrounds an active gathering of nature and humans in an ongoing way. For example, the ordering of natural and human resources in the creation of electricity and light continues with the consumption of light. Thus, Gestell "means literally the reunion of the placing, arranging, regulating, ordering," which Ciborra and Hanseth (1998, p. 318) etymologically clarify:

> "Gestell means in German 'skeleton,' frame or shelf. Note, in passing, that the word 'Untergestell' means chassis and infrastructure (again meant as a light physical support). But Heidegger uses the word Gestell in a new sense stemming from the two parts composing the word in German: the prefix 'Ge' and the word 'Stelle' derived from the verb 'stellen.' 'Ge' in German is the prefix that denotes reunion, gathering, or collecting and reassembling (think of Ge-sellschaft = society; or Ge-meinschaft = community; or, the example introduced by Heidegger himself, Gebirge = mountain (Bergen) chain). Stelle and stellen have a variety of meanings. The noun means place, spot, location. The verb means generically put, place, stand, set, arrange, regulate, provide, order, etc."

Gestell, as an enframing way, includes temporality. There is a destining, never reached, which comes out of what is early, and it is through such an ongoing way that technology is revealing. Emphasising this temporality, Heidegger argues that modern technology takes all there is, nature and humans, and reveals it as a standing reserve which is continuously in transformation. Water and human workers transform in the creation of electricity, which is consumed and leads to further transformation, for example, wind farms for renewable energy. Following this

understanding, scholars use Gestell for defining infrastructure (Ciborra, 2006, 2007; Ciborra & Hanseth, 1998), albeit with an emphasis on self-reinforcing processes rather than movement itself, which is what matters.

In sum, Heidegger's analysis of the essence of technology as a way of revealing underlies the temporal existence of movement. Such temporal assumption conveys historicity to bring to the foreground movement. Further, this assumption is not nihilistic because what matters is the way of revealing rather than an illusionary representation taking the shape of a stable ending form — a structure. In other words, any structure, self or outcome is without a temporal end because of movement. While useful for addressing movement, however, Heidegger's take on technology also conceals movement. As a way of revealing, technology does not lie only with human beings but is still subordinate to the human experience, which belongs only to human beings.

Considering a centrality in human experience, Heidegger foregrounds a perspective of Gelassenheit where change is momentarily through openness and nearness (Heidegger, 1966; Pezze, 2006). To give a "way out" of Gestell, which is towards danger and death, Heidegger argues for change through revealing moments that support a new thinking. As thinking, this understanding of change is momentary and lies only with a few humans who can practice it before falling back into the enframing way of technology. Heidegger conveys such revealing instant and passing moment as in-turning (Heidegger, 1977). Through his later essays on Gelassenheit, understood broadly as releasement, he foregrounds change as awakening (Heidegger, 1966).

For Heiddeger, everything lies in a way, and in such singularity, nature is reduced to a historicity where development occurs momentarily. In other words, a revealing way that draws attention to a human endeavour ethically undermines nature by emphasising human spirituality and uniqueness with a particular way of thinking different from that which is natural; and from movement. Amid such isolation, standing on Bateson's ecological soil, any structure, self, or outcome is "Teilsein (being-part-of) not Dasein (being-in)" (Márton, 2022, p. 254).

Along

Drawing from Bateson's ecological understanding, no self's experience is on its own. Experience as mind is natural — eco and logical. This perspective implies that any structure, self, or outcome is with others and not ending with itself. There is no separation or process isolation. Instead, there is togetherness whereby nature is not subordinate to human experience, neither is human

experience subordinate to a narrow realist assumption where natural mechanisms govern. Ways are along ways.

Throughout his scholarly life, Bateson comes to argue for ecology to redress any separation between mind and nature (Bateson, 1972). Like Heidegger, Bateson begins with the means to an end understanding characterising technology and scientific practice, but also war and mental pathologies. However, Bateson has a different take on stasis based on stable abstracted forms — ends. By looking into how the individual is bigger than one thinks, there is an "ecology of mind" because the individual is with nature and not abstracted from it. Therefore, Bateson foregrounds movement by attending to the relationship between mind and nature, which brings the mind outside the bounds of the individual. In other words, the individual *is* always bigger than thought, meaning movement is natural and coexisting.

Bateson's critique on ends and their stasis begins with conscious purpose, which takes place when the mind resides inside a self. Consequently, there is a conscious purpose that, misleading, emphasises disruptive change where a self transcends to a better state at the expense of the environment. Thus, conscious purpose may lead to the destruction of the environment and the individual self, which Bateson conveys as pathologies of epistemology. This argument against the conscious self, which is bounded to the individual, is based on the conclusion that the unit of mind and the unit of evolution are the same.

Bateson defined the mind unit as information, as difference, based on a cybernetics interpretation. Broadly, this cybernetic interpretation argues that the unit of the mind is relational and that reality is with differences. Following Alfred Korzybski's statement, "the map is not the territory," Bateson illustrates the unit of mind as what gets from the map to the territory, which does not belong to the map, the territory, or as an in-between two stable things, or ends. Instead, the unit of mind is differences, meaning transformations. The territory has differences in height and space, which through differences in measurements, bring about differences in illustrations, which through differences in perception, bring about differences in mental understandings. With this background comes Bateson's definition of information as a difference that makes a difference, which draws attention to movement.

With similitude to the description of the unit of mind, Bateson approaches the unit of evolution. Bateson acknowledges the accomplishment of Jean-Baptiste Lamarck to explain the mind through natural developments rather than the other way around. Instead of explaining what was out there, the mind came to be that which had to be explained through evolution. Bateson, however, criticises evolutionary views for leaving the mind within a homogeneous organism.

These individual-oriented evolutionary views drive attention to the control of the environment and individual adaptation. Such an approach leads to the destruction of nature, the environment, and the organism.[15] For example, "we may say that 'mind' is immanent in those circuits of the brain which are complete within the brain. Or that mind is immanent in circuits which are complete within the system, brain plus body. Or, finally, that mind is immanent in the larger system — man plus[16] environment" (Bateson, 1972, p. 317). Thus, Bateson foregrounds the survival unit as heterogeneous, not delimited by the skin. What evolves is organism-with-environment. Or differently, the unit of mind, as difference, and the unit of evolution *are* the same.

No self ends with itself because the self is with the environment and others. Mind and nature belong together. "In the natural history of the living human being, ontology and epistemology cannot be separated… It is awkward and incorrect to suggest that they are separable in human natural history" (Bateson, 1972, p. 314). Thus, the whole of the mind does not lie in a part. Change is conservative, meaning that it is about maintaining what is and changing with the environment. This does not imply that purpose driven approaches should be replaced. Rather, for Bateson, it is about bringing humility to purposeful driven activities and a synthesis that would incorporate heterogeneity. An ecology of mind.

What is important in his understanding is that by critiquing conscious purpose and Lamarckian evolution views, Bateson foregrounds a diverse, heterogenous conditioning, which brings up a second assumption on movement. Rather than stasis, there are patterns of relationship which do not reduce the individual to a conscious, purposeful self. Bringing the individual mind to be with nature means that any temporary outcome is with others; it cannot be isolated. Therefore, there actually is movement in the extraordinary moments of revealing Heiddeger would argue, because there is variety, and no outcome or change resides inside a self. In synthesis, the self *is* larger than one thinks. In concord, an ecology of mind brings up a second assumption for movement as natural and coexisting.

However, there is an issue. Bateson creates movement from an immanent non-moving whole: "The mental characteristics of the system are immanent, not in some part, but in the system

[15] Imagining present risks regarding climate change serves to illustrate how the individual survival of humanity through the control of natural resources in the environment is leading to the environment's destruction, which is now a risk for humanity.

[16] These emphases are made on the original text.

as a whole" (Bateson, 1972, p. 316). Thus, there are tensions following trial-and-error[17] and self-reference, which take place with a non-moving whole. Such perspective starts from the stasis of logical types in Principia Mathematica by Alfred North Whitehead and Bertrand Russell. Bateson borrows the argument that the class category, "whole," cannot be a member of itself. Based on formal logic, "a class of classes cannot be one of the classes which are its members; a name is not the thing named" (Bateson, 1972, p. 280). In this static view of wholeness and causality, Heidegger gives a way for movement. With his understanding of technology's causality as Gestell, Heidegger adds movement to Bateson's immanence, and nature becomes historical. Similarly, Bateson adds movement with nature and coexistence to Heidegger's inward isolation. Put differently, it is *along ways*.

Conclusions on Infrastructure Development

Following the metaphor network, infrastructure does not reside in a bounded thing. Infrastructure conveys structure and activity as it is human and technological. Within this sociotechnical perspective, two streams on infrastructure differently foreground its development. First, following endurance in structure, past structure is separate from and conditions new structure. Second, when there is an outcome for structure, structure carries with it multiple conditioning relationships in present occasions. In both streams, tensions underlie ends in infrastructure development. Infrastructure continues following tensions between old and new delimiting structures. Alternatively, infrastructure occurs when tensions resolve with an outcome for an ending structure in present discontinuous occasions.

Although these two research streams are useful, they each disregard movement. They leave the development of the global payment infrastructure puzzling, also giving rise to ethical concerns. Nevertheless, their intellectual antecedents, namely Martin Heidegger's and Gregory Bateson's works, give ground to address movement *along ways*. As the following chapter extends, what is a structure in prevailing research streams serves to find *infra*structural *ways* that are revealing, temporal, natural, and coexisting and which help redress structure beyond ends.

[17] Bateson's understanding of the cybernetic process is self-referential. For example, note 14 illustrates a self-reference with environmental changes being created humanity's control over environments.

CHAPTER FOUR

Case Study of Global Payment Infrastructure 1973–2030

This inquiry performs case study research. Considering the case of the global payment infrastructure demands moving beyond a single organisation or region, the framing of this case begins with low-value global payments. There is also a focus on payments primarily emanating from Europa and going to the Global South. In addition, situated accounts of organisations, historical accounts, and prospective narrative accounts all contribute to framing the case of the global payment infrastructure without backgrounding movement. This data corpus includes global payment infrastructure's present, past, and future, and it documents the 1973–2030 period.

The data collection and analysis follow principles for abduction, which is an analytical movement that includes existing knowledge while departing from it — "a leading away" (Timmermans & Tavory, 2012, p. 170). This means that the analysis moves from the endurance of and an outcome for structure towards the infrastructural ways in which global payment structures are and develop. Drawing inspiration from narrative understandings (Czarniawska, 1997, 2004), metaphorical narratives convey these infrastructural ways as they address the development of the global payment infrastructure with movement. Prior to discussing the analysis that leads to these narratives and the movement they convey, the chapter proceeds with the case framing and data collection.

Framing a Case of the Global Payment Infrastructure

The case of global payment infrastructure is revelatory and paradigmatic. This means studying this case remains a task and that addressing this case reveals a new theoretical approach (Flyvbjerg, 2006; Yin, 2018). With this basis, the empirical research starts from global payment between individuals to frame global payment infrastructure. This work describes these payments as low-value global payments, which include, to a major extent, remittances.[18] However, other global payments between people and small businesses are also part of low-value global payments. Moreover, low-value global payments account for large-value global payments in the sense that they come to form such larger payments.

In addition to the emphasis on low-value global payments, the framing of the case begins with a European perspective. The case is global, then, because low-value global payments reach countries around the world that have relationships with Europe. For example, global payment infrastructure reaches many developing countries, and its changes affect individual lives in these countries (Acosta, 2011, 2020; Acosta et al., 2008; United Nations, 2015), even with a hefty European emphasis. Thus, emerging academic discourses and industry reports attend to and document activity in global payment infrastructure (BIS, 2017; Gomber et al., 2018; Nakamoto, 2008; Sveriges Riksbank, 2018a).

Furthermore, framing a case of global payment infrastructure lies beyond a single identity or infrastructure part. Following Yin (2018, p. 14), a case study "investigates a contemporary phenomenon (the 'case') in depth and within its real-world context." However, considering its systemic nature, the global payment infrastructure includes context, which means context and case are not separable and singled out (Avgerou, 2019; Mousavi Baygi et al., 2021) but in movement (Kessel & Giraldo-Mora, 2023). This means the phenomena, case, and real-world context are together and not easily framed through the identity of an organisation, system, country, function, or infrastructure part within a context. Therefore, the framing of the global payment infrastructure as a case better follows Yin's (2018, p. 14) second part of the definition of a case study, which argues that "the boundaries between phenomenon and context may not be clearly evident." Or, as Bateson (1972, p. 338) highlights, it is "important to see the particular utterance or action [the

[18] Remittances are defined in relation to personal transfers as consisting of "all current transfers in cash or in any kind made, or received, by resident households to or from other non-resident households" (United Nations, 2006, p. 3).

'case'] as part of the ecological subsystem called context and not as the product or effect of what remains of the context after the piece [the 'case'][19] we want to explain has been cut out from it."

With this background, the framing of the global payment infrastructure case begins with four situated accounts of organisations (Klein & Myers, 1999; Walsham, 1995) and goes beyond them (Eisenhardt, 1989; Flyvbjerg, 2006; Wynn & Williams, 2012), as follows,

- Quick Remittance Service (QRS)[20] is a global payment provider in the UK and allows its customers to transfer funds to and from Latin America. To a lesser extent, QRS also offers its services in Europe, Russia, The Commonwealth of Independent States (CIS) region, and Central and North America. The organisation is also owned by shareholders of one of the largest private global banks in the CIS region and is part of this bank's global expansion strategy. Thus, QRS foregrounds global payment infrastructure already present and documents a retrospective insight.

The Society for Worldwide Interbank Financial Telecommunication (SWIFT), Aryze, and MakerDAO give a present and prospective insight for understanding global payment infrastructure and its development.

- SWIFT is a global member-owned cooperative and the world's leading provider of secure standardised financial messaging services between financial organisations, as detailed in the second chapter of this thesis (Scott & Zachariadis, 2012). SWIFT has a recent GPI project, which uses distributed ledger technology[21] to increase the efficiency and automation of its global payment service. In addition, the organisation is transitioning to ISO 20022 payment data standard.
- Aryze is a start-up developing digital money services through a digital token backed by fiat currency to support global payments. Rather than developing a new organisational arrangement, Aryze is legally integrating while also using distributed ledger technology for the development of its global digital payment token.

[19] The author of the thesis did these clarifications.

[20] This is a fictitious name.

[21] Broadly, distributed ledger technology is a range of sociotechnological procedures for the validation of data creation that minimise reliance on a single system or organisation (Giraldo-Mora, 2018).

- ∞ MakerDAO, lastly, is an open-source organisation built on Ethereum.[22] The organisation supports accessibility to payment services through a digital token paired with the United States Dollar (USD) while relying on a non-banking organisational arrangement. MakerDAO pairs the value of its digital token DAI to USD with the use of Smart Contracts that respond to price changes. Along, MakerDAO also uses a voting mechanism and governance token based on Ethereum for changes in its protocol.

The study of these three organisations in relation to Quick Remittance Services (QRS) depicts a present development process of the global payment infrastructure (Giraldo-Mora et al., 2019, 2020). However, these organisations create boundaries in the global payment infrastructure, which backgrounds movement giving rise to tensions coming from these bounds. Against this backdrop, this study adds historical accounts. These accounts build from those of organisations to bring a temporally long emphasis. Such an approach is close to emerging studies of infrastructure development, which consider the situated relevance of infrastructure together with its enduring qualities beyond such situated accounts. For example, emerging realist studies that aim to account for the materiality of social reality foreground infrastructure's enduring and historical qualities (Archer, 1995; Leonardi, 2011; Scott & Orlikowski, 2022; Wynn & Williams, 2012). In methodological complement, Klein and Myers (1999) also argue for a principle of contextualisation, which considers a historical background in interpretative research based on situated accounts. Thus, historical accounts from the Bank of International Settlement (BIS) and SWIFT develop the findings of the described situated accounts.

Lastly, appreciative narrative accounts from executive interviews give a further prospective framing on the case of global payment infrastructure and its development. Executives with more than ten years of experience in global payment give an account of where such infrastructure comes from, where it is, and where it is going. These appreciative narrative accounts, together with historical and situated accounts of organisations, bring to the foreground continuity as movement because such movement is beyond a present history ending with critique and emancipation (Foucault, 1977; Myers & Klein, 2011). Figure 4 below illustrates these different accounts framing the case of the global payment infrastructure.

[22] Ethereum is an open source blockchain-based distributed computing platform that features smart contracts scripting functionality and public consensus mechanisms (Wood, 2014).

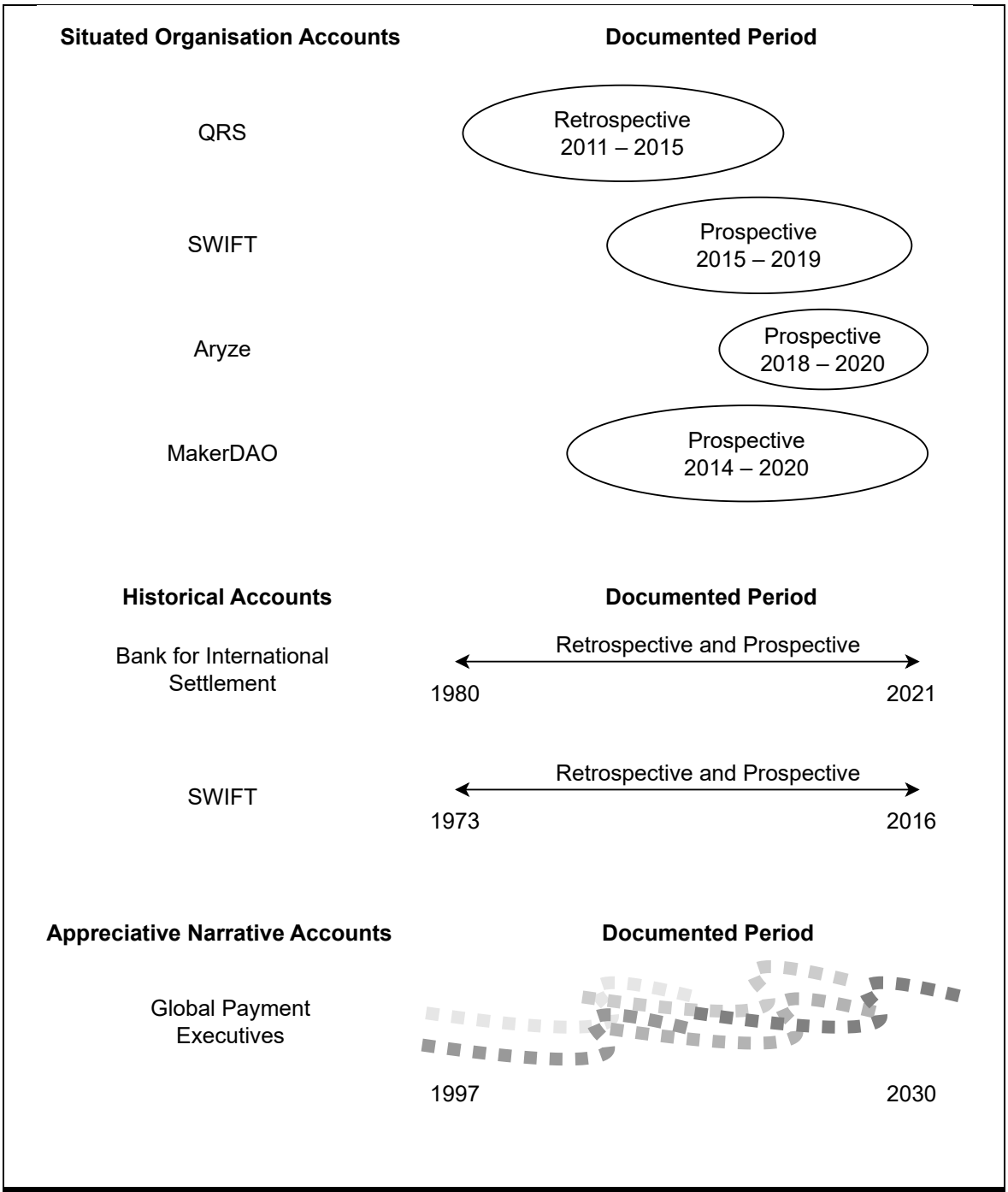

Figure 4. Research Accounts Framing the Case of Global Payment Infrastructure

Data Collection of Situated, Historical, and Narrative Accounts

With the basis outlined, organisations' data were collected between 2017 and 2022. They included observations, interviews, and documents from the four organisations already mentioned, Quick Remittance Services (QRS), the Society for Worldwide Interbank Financial Telecommunication (SWIFT), Aryze, and MakerDAO. The study of these organisations allowed becoming part of the phenomena studied while documenting a retrospective and prospective global payment infrastructure development. For example,

- At QRS, I worked in the customer service department for two years prior to its sale to one of the largest private global banks in the CIS region. Following the acquisition of the company, I continued working at the organisation for another two years. As part of its executive team, I contributed to the creation of the organisation's global payment network, financial management, the creation of products and services, the development of its software, the automation of its compliance procedures, and the envisioning of its strategy and future. Following this experience, I studied the organisation's documents, conducted interviews, and carried out observations to recall such experiences with research intentions. Specifically, the purpose of studying this organisation was to understand how global payment infrastructure is.

After the study of QRS, three organisations, namely SWIFT, Aryze, and MakerDAO, illustrate different emphases in global payment infrastructure development. For example,

- At SWIFT, I followed presentations by the organisation's executives and visited the organisation's headquarters and its premier conference Sibos to have further discussions with its executive teams. Data from SWIFT were collected from observations, interviews, and documents, which relate to a functional development in global payment infrastructure. This data includes SWIFT work for increasing global payment speeds with the application of distributed ledger technology in its GPI service. In addition, the company's recent work on instant payment, both within countries (e.g., Australia's New Payments Platform - NPP) and across regions (e.g., Europe's TIPS), also foregrounds its future emphasis on speed and traceability of global payment.

- ∞ At Aryze, similarly, I followed public communication and presentations by its executive team to gain insight into the development of the organisation. Data from Aryze were collected from observations, interviews, and documents, including the organisation's blog and internal documents. Specifically, Aryze's emphasis on developing a digital payment instrument gives a different approach to the development of global payment infrastructure. Specifically, a stable "coin" or "token," which is programmable by achieving "the best of both worlds" following all regulatory requirements in the development of this digital global payment instrument. Even though the organisation's emphasis follows the payment developments of Bitcoin (Nakamoto, 2008), Aryze has continuously aimed to be regulated, initially as an e-money institution and now as a full reserve bank.
- ∞ Lastly, at MakerDAO, I also collected data from observations of presentations and recorded online meetings, interviews with its executive team, and documents of the open-source project. Even though MakerDAO's global payment development also follows a digital "token," it is centred on not having a central governing entity for payment or for changes in its protocol. Such emphasis centres on regulation in global payment infrastructure development. There is a non-banking regulatory arrangement following the ideals of a decentralised financial system that is peer-to-peer. MakerDAO's digital token follows a set of pre-established procedures encoded in smart contracts, which encourage the sale or purchase of this token when its price deviates from the United States Dollar. Further, there are voting mechanisms to ensure changes in the protocol are not reliant on a single entity. For these reasons, the organisation refers to itself as a "decentralised autonomous organisation."

Table 5 below summarises data from these different organisations as well as further industry-related sources. These latter sources include documents from the European Central Bank and the World Bank describing global payment and other industry conference presentations. Of importance are observations at the International Association of Money Transfer Networks (IAMTN). IAMTN is a global non-profit association for global payment providers serving developing regions and providing data and information to the World Bank and the United Nations.

The close study of these different organisations gives a retrospective and prospective view of global payment infrastructure and its development. As already outlined, however, global

payment infrastructure and its development are beyond these situated accounts of organisations. For example, SWIFT, Aryze, and MakerDAO are not making new global payment infrastructure de novo. These organisations exist with already present global payment infrastructure, which also includes these different organisations. MakerDAO, for example, is with infrastructure allowing the transfer of funds to Ethereum's cryptocurrency ether, which in turn allows for the creation of its institutional arrangement and global payment development. Similarly, QRS may foreground a retrospective view of global payment infrastructure, yet such a beginning of global payment infrastructure does not end with QRS. Infrastructure continues beyond these organisations, both in longevity and diversity.

Table 5. Summary of Organisations Data

Data Source	Observations	Interviews	Documents	Documented Period
Quick Remittance Services (QRS)	30 hours	5 Interviews	8,806 documents	2011–2015
Society for Worldwide Interbank Financial Telecommunication (SWIFT)	45 hours	2 Interviews	79 documents	2015–2019
Aryze	3 hours	2 Interview	45 documents	2018–2020
MakerDAO	10 hours	2 Interview	85 documents	2014–2020
Other Contextual Sources	35 hours	1 Interview	25 documents	2006–2019

Adding to the study of organisations' situated accounts are historical data collected during 2020 and 2021, primarily from the Bank for International Settlement and Publishers with SWIFT's historical data. These data document the digitalisation of the global payment infrastructure. The data from SWIFT follows the seminal works of Susan Scott and Markos Zachariadis, which trace the organisation's historical development from its inception in 1973 until 2012. Adding to these data is also a 2016 speech from one of the organisation's executives with reflections on linking interbank global payment systems. Data from the Bank for International

Settlement is in the form of reports published at the institution between 1980 to 2021 and covering a development period beginning from 1970. These reports follow the objectives set at the foundation of the Bank for International Settlement for central bank cooperation and the development of an international bank guarding the maintenance of global payment infrastructure (Toniolo & Clement, 2005). As Figure 5 illustrates, the creators of such reports are global payment executives, part of the global payment infrastructure, who meet to discuss and reflect upon how this infrastructure is, how it was, and where it is going.

Reports collected at the Bank for International Settlement were curated from the publication categories on the bank's website. This curation began by reading the titles, forewords, and summaries of the following publications on the bank's website:

- 120 BIS papers
- 985 Working Papers
- 120 FSI insights papers
- 696 papers from the Basel Committee on Banking Supervision. This committee works on setting global standards for the prudential regulation of banks and offers a forum for cooperation on banking supervision.
- 68 papers from the Committee on the Global Financial System. This committee centres on finding and assessing sources of stress in global financial markets.
- 199 papers from the Committee on Payments and Market Infrastructures. This promotes, monitors and makes recommendations about the safety and efficiency of payment, clearing, settlement and related arrangements. The committee also is an international standard setter.
- 18 papers from the Markets Committee. This committee addresses recent developments in financial markets while considering potential future trends. It also exchanges information about the short-run implications of current events for the functioning of financial markets and central bank operations, serving as a forum for these banks.
- 74 papers from Other Publications
- 63 papers from the Discontinued Paper Series
- The Basel Framework Document Consolidate

This initial curation led to a total number of 245 documents, the second one to 156 papers and the third one to 110 manuscripts from the institution. In the initial curation, quantitative-

oriented research titles were excluded (e.g., "Effects of a mandatory local currency pricing law on the exchange rate pass-through"), and attention came to descriptive or explanatory research titles (e.g., "Fragmentation in global financial markets: good or bad for financial stability?"). Also, there were tendencies to focus the data collection on "payment systems" and "infrastructure." The second curation followed the ideas developed through the study of four global payment organisations and a skimming of all publications. Particularly, the focus came to the different development emphases of SWIFT, Aryze and MakerDAO, which extends beyond these organisations part of the global payment infrastructure. The third curation took place by reviewing all articles and excluding reports that were centred on a country or region, which, while valuable, tend to background cross-country relationships. For example, titles such as "Payment Systems in the Group of Ten Countries," "Payment Systems in Eleven Developed Countries," and "Payment Systems in [Country Name]" are not part of the final selection.

Lastly, other relevant reports were added purposefully to document definitions or relevant global payment infrastructure developments. Table 6 summarises the final manuscripts accounting for a historical continuum inspired by and beyond the four organisations previously studied. Yet, these historical accounts also end with the present publication years.

Table 6. Summary of Historical Data

Data Source	Reports and Studies	Publication Years	Documented Period
Bank for International Settlement	110 Reports	1980–2021	1980–2021[23]
Publishers with SWIFT's Historical Data	1 Book, 1 Study, 1 Speech	2012, 2014, 2016	1973–2016
Other	1 Report, 1 Study, 1 Speech	1989, 1996, 2009	1970s–1990s, 2009

[23] Even though 1980 and 2021 are end dates for the development period recorded in these documents, some of these narratives go backwards and forward in their descriptions. For example, documents from 1980 and 2021 have retrospective orientations with expressions as "over the last decade," present orientations with expressions as "global payment is," and prospective orientations with expressions as "for global payment, distributed ledger technology could."

Annex B: Members of the working group

Chairman	Klaus Löber (European Central Bank)
Reserve Bank of Australia	David Emery
National Bank of Belgium	Filip Caron
Central Bank of Brazil	Daniel Gersten Reiss
Bank of Canada	Wade McMahon
European Central Bank	Dirk Bullmann
Bank of France	Paul Capocci
Deutsche Bundesbank	Johannes Klocke (until October 2016) Heike Winter (from October 2016) Marcus Härtel (from October 2016)
Hong Kong Monetary Authority	Shu-pui Li (until November 2016) Nelson Chow (from November 2016)
Reserve Bank of India	Supriyo Bhattacharjee
Bank of Italy	Michela Tocci Giuseppe Galano
Bank of Japan	Shuji Kobayakawa Akiko Kobayashi
Bank of Korea	Dong sup Kim
Bank of Mexico	Angel Salazar Sotelo
Netherlands Bank	Kirsten van Driel
Central Bank of the Russian Federation	Vadim Kalukhov
Saudi Arabian Monetary Authority	Mohsen Al Zahrani
Monetary Authority of Singapore	Tze Hon Lau
South African Reserve Bank	Arif Ismail
Sveriges Riksbank	Björn Segendorf
Swiss National Bank	Marco Cecchini Nino Landerer
Bank of England	Simon Scorer
Board of Governors of the Federal Reserve System	David Mills Brendan Malone
Federal Reserve Bank of New York	Wendy Ng (until November 2016) Ray Fisher (from November 2016) Vanessa Lee
Secretariat	Paul Wong Emanuel Freire

Significant contributions were also made by Andrea Pinna (European Central Bank); Bas Koolstra (Netherlands Bank); and Ayse Sungur, Pankaj Setiya and Mario Griffiths (Secretariat).

Figure 5. Illustration of Report Creators at the Bank for International Settlement

Adding a further prospective orientation are appreciative narrative accounts collected during 2022 through interviews with experienced senior executives who are part of the global payment infrastructure. The sampling followed the study of organisations and historical reports documenting the global payment infrastructure. For example, the interviewee with the code INT1 had worked on global payment developing integration processes as well as payment networks, which relate to Aryze and, more generally, global payment instruments. This interviewee was also involved as director of a global payment provider in the United Kingdom during the introduction of new licencing regulations for global payment services by the Financial Conduct Authority. Such regulation in global payment relates, albeit differently, to how MakerDAO regulates its global payment services. Moreover, during its most recent work leading the development of platform integrations at a leading global payment provider, this executive also took part in reviewing how to connect messaging and settlement in global payment to increase global payment speeds. This latter development relates to the works of SWIFT and functions in global payment more generally.

To better convey the ways the global payment infrastructure develops, the interviews followed a positive inquiry approach centre on relevant experiences as recalled by interviewees (Flanagan, 1954; Schultze & Avital, 2011). A positive inquiry approach follows the involvement of interviewees in the phenomena studied while looking into a prospective emphasis, which relates to retrospective insights (Schultze & Avital, 2011). The interview structure follows a relevant experience (Flanagan, 1954) and asks where it comes from, where it is going, and where else it may go, which accounts for continuity (Mousavi Baygi et al., 2021) as movement. Beginning by discussing interviewees' most recent relevant experiences, these are then extended backwards by discussing previous experiences, and then diving deeper into where these previous experiences came from. From these different past and present experiences, interviews centre on imagining future experiences and then different future ones. Importantly, such experiences follow interviewees' work on global payment infrastructure and the development emphases considered in previous data collections. For example, for INT1, some of the questions we discussed were:

- What was the most important work you were doing in the development of an API integrations platform for this large global payment provider based in the UK?
- How do you imagine your work for the development of an API integrations platform changing how global payment works?

- How did you and your organisation end up working in an API integrations platform?
- How is your work in an API integrations platform different from existing integration processes?
- If you were to reimagine integrations and global payment, how do you think they could be working in 10 years?

The result of these data is appreciative narrative accounts, which, together with situated accounts of organisations and historical accounts, document the ways the global payment infrastructure develops. As Table 7 below illustrates, these interviews with global payment executives follow their years of experience and have a prospective development period, which I framed until 2030 during the interview. Furthermore, Appendix B gives a detailed description of the study's data corpus.

Table 7. Summary of Narrative Data

Interviews	Criteria	Experience in Years	Documented Period
22	Executives with holistic industry experience who have worked developing global payments	406	1980s–2030

Abduction Analysis Process

The data analysis took place together with the case framing and data collection. The analysis is based on abduction, [24] which is "an inferential creative process of producing new hypotheses or

[24] There are different perspectives on abduction analysis. This work partially follows Timmermans and Tavory (2012) approach to abduction as it relates to the thesis's theoretical grounds. For example, Timmermans and Tavory (2012) develop the pragmatist understandings of Peirce (1998), which follow a naturalistic instinctive occurrence, with Heidegger's (1927) processual understandings. Timmermans and Tavory (2012) also suggest being theoretically agnostic, the development of new causal understandings through hypotheses, and tensions in abduction analysis. However, based on the theoretical development of this work, these latter suggestions on abduction are probably better conveyed here as being theoretically aware of and comfortable with prevailing and different understandings and explanation forms as well as how they relate (Bateson, 1972; Heidegger, 1966). Timmermans and Tavory (2012) also emphasise this latter argument.

theories" where "a researcher is led away from old to new theoretical insights" (Timmermans & Tavory, 2012, p. 170). Abduction emphasises a leading away from prevailing understandings towards novel ones based on anomalies, where discovery and justification are inseparable (Timmermans & Tavory, 2012). Consequently, the data analysis process led away from (endurance of and outcome for) structure towards the infrastructural ways in which global payment structures are and develop. Further, the abduction process involved multiple analyses, which follow from different theoretical assumptions. Without such methodological variation, there is a risk of reproducing the status quo that abduction helps to revisit (Heidegger, 1977).

Accordingly, the leading away is focused on the anomaly of continuity in global payment infrastructure, taking place as accumulation and unprecedented changes. For example, by looking at the global payment provider QSR, Secure File Transfer Protocol (SFTP), since the early 2000s, has been the protocol for connecting servers across different global payment organisations. By looking at the development of other global payment providers, however, multiple structures for payment remain next to SFTP connections. For example, SWIFT proprietary message structure, often known as Message Type (MT) forms in a business context, has remained since banks transition away from Telex in the 1970s. Application Programming Interfaces (APIs), the move towards the new standard ISO20022, and as documented with Aryze and MakerDAO Blockchain-based connections and digital tokens also accumulate with other structures.

As well as accumulation, there is unprecedented infrastructural change fundamentally redefining global payment. Incidents are encounters documenting such unprecedented development (Alport, 1940, 1954, 1967). For example, the September 11 or 9/11 attack in the United States implied higher regulation and licensing for global payment providers in the early 2000s. The financial crises of 2008 came with higher compliance standards for banking organisations. After this crisis, Bitcoin took form and, most recently, Blockchain networks and digital payment tokens for global payment. Similarly, new regulations imposed by banks on global payment providers such as QRS meant the closure of accounts and services to Somalia, among

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Moreover, in addition to the work of Timmermans and Tavory (2012) and with the same spirit, Sætre and Van de Ven (2021) emphasise the importance of abduction for theory development in management studies. Even though it has value, this perspective on abduction follows a Lamarckian evolution model and dialectic tensions for the development of anomalies and hunches, respectively. Thus, it is relevant to note once more Timmermans and Tavory (2012) work on extending the instinctive assumptions of Peirce (1998) in abduction analysis with Heidegger's philosophy. On the same page are Bateson's (1972, pp. 432–473) reflections on Lamarckian evolution, which would emphasise ecology over individual endogenous instinctive change.

other countries. More recent incidents are the closure of services supporting Euro digital tokens following the European's Union Markets in Crypto-Currency Assets (MiCA) regulation.

Such unprecedented change and accumulation in global payment infrastructure drove the initial analysis, which subsequently led to inquiring movement in infrastructure development. Three abduction principles guided the process leading away from (endurance of and outcome for) structure to the ways in which structure is and develops. These principles are revising, defamiliarization, and alternative casing (Timmermans & Tavory, 2012).

Beginning with the principle of *revisiting,* different data accounts, recordings, transcriptions, coding, and memo writing inscribed two different enduring observations and experiences. Accordingly, there was a chance to revisit, or better reexperience, these two observations and develop novel insights (Timmermans & Tavory, 2012). The first one is the accumulation and unprecedented change following the endurance of and outcome for structures in the global payment infrastructure. In the study of global payment organisations, for example, Blockchain technology and Bitcoin appear alongside the incidents of the 2008 financial crisis. While being part of existing regulatory frameworks, Aryze argues such token redefines money by making it "programmable" and consequently enabling global payment services to serve specific needs of people and organisations and inclusion in regions never reached before. MakerDAO's digital token came to exist with arguments for redefining global payment infrastructure by not relying on a banking arrangement for the creation of its token but rather a "decentralised autonomous organisation." Similarly, SWIFT came to develop its GPI service following ideas grounded on Blockchain technology, which drives efficiency and automation in its global payment service. However, even though the incidents of the 2008 financial crises and the Bitcoin and Blockchain structures illustrate changes, these structures and unprecedented changes relate to prevailing structures such as QRS SFTP networks, which persist and show accumulation.

The second observation in the analysis process is that Aryze, MakerDAO, and SWIFT document different emphases in the development of global payment infrastructure. Aryze emphasis on the development of a stable token appears as a payment instrument, which the European Central Bank (2009, p 20) defines as "a tool" for making payments. Stable tokens are an example, but also payment cards are such tools or "devices" for paying (ECB, 2009, p 3). MakerDAO's emphasis on not relying on banks for its payment token illustrates a payment regulation approach, which often associates to the development of rules and supervisions for paying. For example, know-your-customer documentation requirements as in QRS or the governance token and transaction settlement of MakerDAO, which is based on Ethereum's

Blockchain. Lastly, SWIFT's emphasis on increasing efficiency in its global payment messages using Blockchain technology relate to payment functions, which are the different activities for paying, such as the calculation of foreign exchange price and the transferring of data.

These two observations, 1) of the change and accumulation and 2) of the payment instrument, regulation, and function emphases in the development of global payment infrastructure were, revisited. Accounts of global payment organisations, historical reports, and narrative interviews facilitated going back to past and future structures and incidents in the global payment infrastructure. This process allowed reexperiencing the payment instrument, regulation, and function emphases in this infrastructural development. The coding of interview transcripts and historical reports, for example, helped studying Aryze, MakerDAOs, and SWIFT approaches again as an infrastructural development that goes beyond these organisations. The codes that began as payment instrument, regulation, and function following the above definitions transformed. Through the detailed writing of memos, as Figure 6 illustrates, and initial research (Giraldo-Mora, 2018; Giraldo-Mora et al, 2019, 2020), this revisiting analysis process implied a second process of defamiliarization.

Defamiliarization is the second principle of abduction, which guided a further analysis process of global payment infrastructure development. Defamiliarization entails distance from the taken for granted, which detailed description, unnatural line breaks, and metaphors facilitate. Detailed descriptions in memos and previous research steered two unnatural line breaks in the study of global payment infrastructure development, which guided this second analytical process. The first unnatural line break is that pragmatically bounding the development of global payment infrastructure, e.g., within a singled-out identity or infrastructure part or technology, gives rise to development tensions (Giraldo-Mora et al., 2020). However, the global payment infrastructure does not fit inside a made-up boundary. In other words, Aryze, MakerDAO, SWIFT, and QRS are not cases of global payment infrastructures. They are cases of global payment organisations that exist because there is infrastructure for global payment. The second unnatural line break is the acknowledgement that global payment infrastructure development temporally lasts; the past matters (Giraldo-Mora et al., 2019). Even though the global payment infrastructure does not fit within global payment organisations or industries with defined boundaries, this infrastructure is not being reinvented in situ each time. The global payment infrastructure is already present and developing; therefore, it is also underlying global payment organisations such as Aryze, MakerDAO, SWIFT, and QRS.

The two unnatural line breaks of an unbounded and an already present and developing global payment infrastructure steered the generation of historical and narrative accounts and distancing from the endurance of and outcome for structure. Attention moved away from the specific applications of distributed ledger technology for global payment and from eventful happenings such as the closure of bank accounts for global payment providers in the United Kingdom. Instead, such (endurance of and outcome for) structures were read retrospectively and prospectively as well as beyond specific organisations through historical and appreciative narrative accounts. For example, prior to the recent distributed ledger technology developments, the quest for straight-through processing in the 1980s and for standardisation in the 1970s extends this present infrastructural development underlying changes for the generation of global payment data. Furthermore, this infrastructural development continues going forward following data from appreciative narrative accounts, which argue for the distribution and creation of payment data and the subsequent extension of global payment to new places. The closure of bank accounts also is still present today and continues under what global payment providers refer to as de-risking, which is a name for banks' low-risk and profit-driven choices translating into the closure of access to banking services to global payment providers.

In addition, following the principle of defamiliarization, this second analysis process revisited the development emphases of instrument, regulation, and function in the development of global payment infrastructure. While using these emphases as guidance for coding, their relationships were also coded following the unboundedness of global payment infrastructure development. For example, the code of payment *instrument and regulation* focused on infrastructural developments involving both aspects together rather than an isolated and therefore bounded development. As the code sample below illustrates, tools and related supervisions for paying are together. The text in bold below highlights the emphases for the coding analysis.

> "Given that a **CBDC** [Central Bank Digital Currency] can **allow for digital records and traces**, it could improve the application of **rules aimed at anti-money laundering and countering the financing of terrorism** (AML/CFT[Anti-Money Laundering/Combating the Financing of Terrorism]), and possibly help reduce **informal economic activities**" (BIS, 2018b, p. 9; BIS4 Report).

The coding for payment *regulation and function* also focused on infrastructural developments involving these two together. The excerpt below illustrates supervision and activities for paying taking place with each other. Again, the text in bold below highlights these emphases for the coding and analysis.

> "**GPI** is not only a **solution** but a **framework** whereby **banks need to confirm the posting** to the beneficiary **within 24 hours**" (SWIFT Observation).

Lastly, the code of payment *function and instrument* focused on infrastructural developments involving these aspects together. In different words, the activities and tools for paying are together, as in the quote below. Here, the text in bold also highlights these emphases for the coding analysis.

> "**stabilisation mechanisms linked to reference assets**, which in principle aim to **minimise fluctuations** in the value of crypto-assets. Examples of such **stabilisation tools** include: (i) **funds held by the issuer or a custodian** that **back the crypto-asset** and are **fully redeemable**; and (ii) **other asset classes (including crypto-assets) that back the crypto-asset**, and which are held by the issuer, a custodian or **recorded in a decentralised manner**" (BIS, 2019a, p. 6; BIS5 Report).

Moreover, these development emphases and the data corpus were analysed retrospectively and prospectively following the finding that global payment infrastructure is already present and developing. This meant studying Aryze, MakerDAO, and SWIFT in relation to prevailing global payment services and their underlying infrastructure, as the case of QRS exemplifies. Correspondingly, retrospective and prospective codes were added in addition to the payment instrument, regulation, and function development emphases and their relationships. Importantly, this temporal distinction was operationalised following textual descriptions and contextual readings by the author. For instance, the first quote below illustrates a present tense description and therefore was considered a retrospective orientation for global payment instruments. The second quote emphasises possibilities and a prospective orientation for global payment instrument. In addition, the first quote describes traditional global payment instruments in remittances, while the second does so with distributed ledger technology, which gives a prospective emphasis based on possibility. The text in bold below highlights these emphases for

retrospective and prospective distinctions, which are analytically defined as “where does it come from?” and “where is it going towards?” (Heidegger, 1966; Foucault, 1977).

> In retrospective,
> “a remittance transfer **is likely to involve** a “settlement chain” - **a series of separate payments**, each of which may be **made differently**” (BIS, 2007, p. 41; BIS1 Report).

> In prospective,
> “a notable property of **DLT** [Distributed Ledger Technology] is the **distribution of responsibilities for updating** the ledger by multiple nodes. These **nodes** can be deployed across **multiple sites,** institutions or even jurisdictions (BIS, 2017, p. 3; BIS107 Report).

The retrospective and prospective coding also took place for relationships among development emphases, which aided in further defamiliarizing from these as relationships. Also, the retrospective and prospective distinction took form within the same type of data. This means the same report or interview would have these retrospective and prospective emphases, as the quotes below illustrate. Worth clarifying is that data was coded in multiple categories rather than exclusively, which gives rise to a “messy process” resembling abduction rather than a “straight-line” analysis. For instance, the quotes below illustrate two relationship codes, those of instrument and regulation and function and instrument, both of which have retrospective and prospective emphases. The text in bold again highlights emphases for retrospective and prospective distinctions and the data sources, e.g., interviews INT14 and INT4, which were reviewed during this second analysis process. Additionally, the long quote gives a sense of the interview process and illustrates how attention to a narrative format began to take place.

> In retrospective,
> “Remember, one of the things about sending money is **the world is really often based on a correspondent banking basis**. And there’s very few banks that have everything… They won’t necessarily have a bank everywhere, so there’s a huge amount of delays in the process of sending money. You don’t see that in Europe, because in Europe we have relatively instant euro, relatively instant pounds, in the US is much slower, but within Europe, pounds and euro are instant.in the rest of the world is not so instant.

Juan Camilo: But I'm wondering, in terms of the actual foreign exchange process, how quick is it?

So you have to distinguish. Remember **foreign exchange is not regulated**. **Payments are regulated**. You can trade all the foreign exchange you want, and you're not a regulated company. But if you pay one dollar from the UK to France, that's a regulated activity. The actual conversion is instant. Foreign exchange markets work instantly. So, the way you have to think about foreign exchange is [pause].

Listen I have until forty-five, if you want more time, I'm happy to talk to you about it. We can schedule to talk again.

So, **the world of currencies is thought of in T, time, plus 0 + 1 + 2**. So, for example, the Swiss franc is a T + 1 currency. That means if you give Euro today and you want Swiss franc, I give them to you the next day (…) So you have T + 0, T + 1, and T + 2, and then within that you have three ways to trade. You have the traditional foreign exchange trade, which is called the spot market trade (…) There's also something called TOD and TOM. TOD is the price for today, trade on the day, and TOM is the price for tomorrow. So, the foreign exchange market will give you today, tomorrow, in spot (…) and for each currency you'd have settle today, settle plus one day, settle plus two days. You, the person, who is sending the money absolutely don't care (…) All you all you want is the lowest price in the fastest service and (…) **What we do is we figure all of that out so that you get the money as fast as possible with as little visibility of any of that internal mechanics as possible**

Juan Camilo: Then, what is it that you do to allow for speed?" **(INT14 Interview)**.

In prospective,
"So, speed is all sorts of things one. **We speed up the process** that the money comes in, we speed up the reconciliation, we have pools of liquidity so that once I have your funds. So once you've given me the money and I have it in my account I can pay it out somewhere else. I don't have to wait for that whole process to happen" **(INT14 Interview)**.

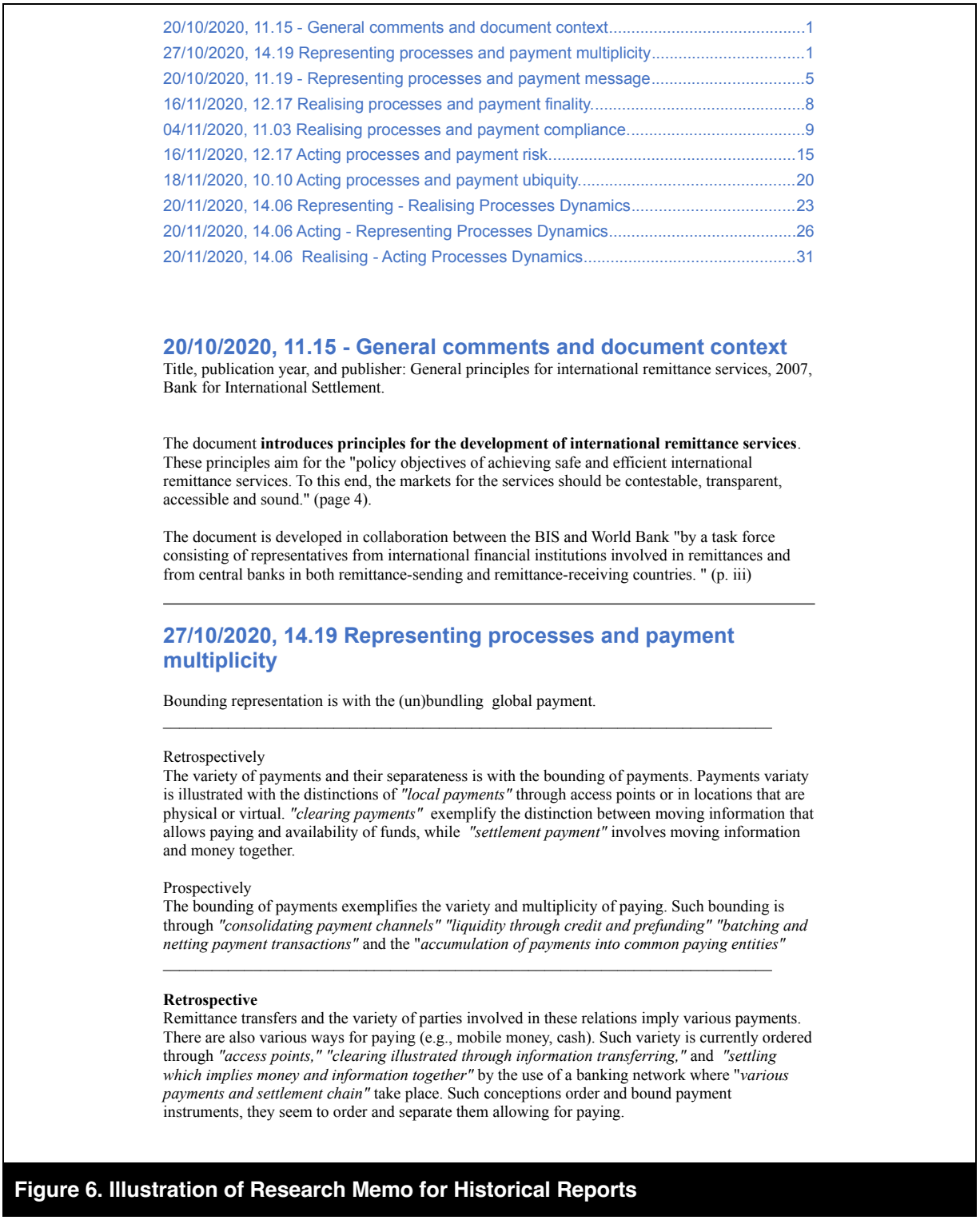
> "in the blockchain, one of the greatest things about blockchain is not so much that it is blockchain, but blockchain operates in markets which are 24/7, right? So, **bitcoin operates 24/7**, the US dollar bitcoin period is 24/7, yen with Bitcoin is 24/7. So **for the first time in the world you have got bitcoin, which essentially is a 24/7 system available to anybody at any time**. But also the **trading happens 24/7, which means in real-time milliseconds transfer of bitcoin to you and I**" **(INT4 Interview)**.

In synthesis, the principle of defamiliarization involved two unnatural line breaks following surprising findings in the development of the global payment infrastructure. One being the boundaries in global payment infrastructure give rise to tensions while such development is with no bounds. The other is that global payment infrastructure development temporally lasts. Even though these findings, defamiliarization from (outcome for and endurance of) structures took place through data beyond the situated accounts of organisations and through more coding and memo descriptions. Specifically, relationships between development emphases and retrospective and prospective orientations in this infrastructure development. The last part of the analysis process was a closer look into metaphors and narratives to understand differently the development emphases of instrument, regulation, function, as well as (the endurance of and outcome for) structures in global payment infrastructures development. While the formation of metaphor and narrative allowed for defamiliarization as much as revisiting the phenomenon, the metaphors and narratives conveying the study's findings took shape in a third analysis process, which centred on alternative casing.

Alternative casing, the last principle, implies casing the data through different theoretical and analytical approaches. In other words, while revisiting the phenomenon and defamiliarizing from the taken for granted, careful coding and field notes also imply making as many links as possible, which gives rise to questions about existing theories. "The trick is to continue analysing the data word by word, line by line, paragraph by paragraph," because alternative casing allows staying closer to the phenomenon and turning surprising facts into "a new game with new rules for thinking" (Timmermans & Tavory, 2012, p. 177). With this principle in the background, the third analysis process centred on going towards movement and the creation of metaphorical narratives to present the finding of global payment infrastructural ways.

This third analysis process involved two parts. First, the explorations of multiple theoretical grounds led away from (outcome for and endurance of) structures to the infrastructural ways preceding and proceeding global payment structures. The development of global payment

infrastructure was first cased through structures, as enduring or with an incident. This initial casing led to perspectives such as critical realism, dialectics, and agential realism to unfold the development of the global payment infrastructure. Correspondingly, evolutionary paths, inertia, and mechanisms were reviewed in two accounts detailed by Giraldo-Mora et al. (2019, 2020).



20/10/2020, 11.15 - General comments and document context

Title, publication year, and publisher: General principles for international remittance services, 2007, Bank for International Settlement.

The document **introduces principles for the development of international remittance services**. These principles aim for the "policy objectives of achieving safe and efficient international remittance services. To this end, the markets for the services should be contestable, transparent, accessible and sound." (page 4).

The document is developed in collaboration between the BIS and World Bank "by a task force consisting of representatives from international financial institutions involved in remittances and from central banks in both remittance-sending and remittance-receiving countries. " (p. iii)

27/10/2020, 14.19 Representing processes and payment multiplicity

Bounding representation is with the (un)bundling global payment.

Retrospectively
The variety of payments and their separateness is with the bounding of payments. Payments variaty is illustrated with the distinctions of *"local payments"* through access points or in locations that are physical or virtual. *"clearing payments"* exemplify the distinction between moving information that allows paying and availability of funds, while *"settlement payment"* involves moving information and money together.

Prospectively
The bounding of payments exemplifies the variety and multiplicity of paying. Such bounding is through *"consolidating payment channels" "liquidity through credit and prefunding" "batching and netting payment transactions"* and the "*accumulation of payments into common paying entities"*

Retrospective
Remittance transfers and the variety of parties involved in these relations imply various payments. There are also various ways for paying (e.g., mobile money, cash). Such variety is currently ordered through *"access points," "clearing illustrated through information transferring,"* and *"settling which implies money and information together"* by the use of a banking network where "*various payments and settlement chain"* take place. Such conceptions order and bound payment instruments, they seem to order and separate them allowing for paying.

Figure 6. Illustration of Research Memo for Historical Reports

However, the anomaly of continuity in the development of global payment infrastructure remained unaddressed, which led to defamiliarizing from these established theories in infrastructure studies. For example, critical realist approaches and those emphasising paths uncover the endurance of infrastructure, albeit change being a sequential transition that does not convey movement. Similarly, agential realist grounds bring to the foreground relationships and continuous change in the formation of lasting structures, which come without precedent and lack the temporally lasting movement of infrastructure development. Consequently, attention came to the ecological and processual philosophies where understandings of infrastructure development stand (Bateson, 1972; Ciborra, 2006; Heidegger, 1977; Star & Ruhleder, 1996). Both philosophical grounds were used to case the data as infrastructural ways following the second part of this analysis process.

Specifically, the second part of this analysis process involved casing the data with emerging themes (Noblit & Hare, 1988) to qualify the different emphases in the development of global payment infrastructure already found. The retrospective and prospective codes of payment instruments, regulation, and function, and their relationships, were thematically coded to understand qualities, which subsequently led to infrastructural ways conveying movement. For example, for the development emphasis on payment regulation, a theme of compliance covering regulatory requirements for paying across country borders emerged. By reviewing these emerging themes, the inquiry arrived at qualities. The theme of compliance, for instance, means a constant validating process of identities for providers and people, which allow for recognising a global payment transaction and for it to happen. The quote below provides an illustration.

> In retrospective,
> "in certain **jurisdictions**, **payment providers are required to obtain a financial licence** (eg a specific **money remitter** licence or a licence as a **bank** or **payment institution**), while in other jurisdictions they are required to enter into **an agreement with banks**" (BIS, 2018a, p. 15; BIS52 Report).

> In prospective,
> "We see that, of course, **we would need a corresponding bank that has a banking license** and can **process foreign exchange**" (Aryze Interview).

Together with the theme of compliance, the theme of finality emerged in the data analysis of the regulation emphasis in the global payment infrastructure development. This other theme means regulation also conveys the moment when a global payment transaction is complete. Such finality led to a second quality of finalising, which foregrounds structures for the recognition of payment completion. For example, finality conveys a regulatory requirement, as the quotes below document.

> In retrospective,
> "**payment-versus-payment (PVP) settlement** is a mechanism that ensures the **final transfer** of a payment in one currency if, and only **if, a final transfer of a payment in another currency occurs**" (BIS, 2013, p. 31; BIS56 Report).

> In prospective,
> "for **DLT arrangements, settlement finality may not be as clear**. In arrangements that rely on a **consensus algorithm to effect settlement finality**, there may **not** necessarily be **a single point of settlement finality**. Further, **the applicable legal framework may not expressly support finality in such cases**" (BIS, 2017, p. 16; BIS107 Report).

Considering the casing of these qualities and the retrospective and prospective development emphases in global payment infrastructure, writing memos, as in Figure 6, allowed for the creation of metaphorical narratives to present infrastructural ways.[25] Following the same example, the quality of validating and finalising were conceived together as an infrastructural way for global payment to pass as real. This infrastructural way is for global payment regulatory structures that allow for a global payment to be recognised as a realisation for global exchange. Based on this last principle of alternative casing, such infrastructural way was named irreversible

[25] Because ways and the movement they convey are different from mechanisms, paths, flows, agential cuts, configurations, entanglements, apparatus, assemblage, correspondence, among other concepts explored, their presentation also requires a different form. Further, discussing these concepts at length goes beyond what this PhD thesis can do. These concepts are present in this note for transparency in the abduction analysis process. For the reader interested in exploring more than this brief mentioning, in no particular order, the works by Karen Barad, Tim Ingold, Bruno Latour, Gilles Delluze, Félix Guattari, Roy Bhaskar, Margaret Archer, and Thomas Parke Hughes are a start to go in depth into such ideas, which are different to movement in this work and with their own extensive explanatory power.

validation, which conveys the infrastructural way for global payment to pass as real, just like how lenses help in seeing and reflecting a non-changing reality. This infrastructural way addresses movement preceding and proceeding structures such as global payment licenses and the finality of payment across banks as well as global payment providers using recent blockchain technologies.

In addition to regulation, the same analysis process took place for the instrument and function development emphases and their relationships. This grounded analysis led away from instruments and functions to the infrastructural way for global payment to be objects and to result from action. For example, global payment orders are global exchange objects that come to be and change with the infrastructural way of granular homogenisation. Similarly, ubiquitous causation is the infrastructural way underlying structures, such as foreign exchange margins and the transfer of data, which allow for the global exchange of funds. Interestingly, the relationships between these emphases brought about other infrastructural ways for the creation of new global payment data, new illicit global payment, and new global payment locations, which explain an unprecedented and temporally long global payment infrastructure development by revealing movement. Table 8 provides a summary of the abduction analysis leading to infrastructural ways, and Appendix C provides a sample of the coding process.

As an ending note, it is relevant to notice the use of metaphorical narratives to present the findings of infrastructural ways, which brings together different research accounts (Noblit & Hare, 1988; Timmermans & Tavory, 2012; Weed, 2005). Narratives not only have an inclusive continuity common in process studies (Cloutier & Langley, 2020), but they also relate present circumstances to antecedents foregrounding a change process (Rantakari & Vaara, 2017, p. 271). As narratives are characterised by having a "story" format, they are causal (Dailey & Browning, 2014, p. 23) while being open (Czarniawska, 1997, 2004). Furthermore, by adding a metaphorical emphasis, different relating storylines (Mousavi Baygi et al., 2021) go beyond any single, lineal, and overreaching narrative account because metaphors help "seeing something from the viewpoint of something else" (Brown, 1976, p. 170). Thus, like narratives, metaphors are inclusive and address a reality that is "perspectival: anything we know is known as something; it is 'construed' from some point of view" (Brown, 1976, p. 169).

Therefore, the analytical outcome of metaphorical narratives conveying infrastructural ways, which cross the situated, historical, and narrative research accounts collected. The infrastructural way of irreversible validation, for instance, underlies payment transactions as much as regulations and organisations in global payment.

Table 8. Summary of Abduction Analysis		
Principle	**Analytical Process**	**Analytical Insight**
Revisiting	Inscribing and going back to persisting observations in global payment infrastructure development through: ∞ Accounts of global payment organisations, historical reports, and narrative interviews ∞ The codes of instrument, regulation, and function	∞ Accumulation and unprecedented change in the global payment infrastructure ∞ The payment instrument, regulation, and function emphases in the development of the global payment infrastructure
Defamiliarizing	Distancing from the taken from granted in (global payment) infrastructure development by: ∞ Describing in memos and collecting more data about where changes came from and where they are going following situated accounts of organisations ∞ Coding relationships among the instrument, regulation, and function development emphases and reading these retrospectively and prospectively	∞ Global payment infrastructure and its development are already present ∞ Development emphases in global payment infrastructure are not isolated nor bounded in global payment organisations or incidents
Alternative Casing	Casing data and findings with different theoretical approaches by: ∞ Reviewing philosophical assumptions of change and casing the development of global payment infrastructure through ecological and processual theory in infrastructure research ∞ Following development emphases and their relationships with a grounded coding that led to emerging themes and qualities, which the writing of memos and, subsequently, metaphorical narratives complement	∞ Global payment infrastructural ways preceding and proceeding (endurance of and outcome for) structures such as compliance requirements ∞ Three infrastructural ways for global payment to be objects, pass as real, and result from action. Three infrastructural ways, along, underlying new global payment data, new illicit global payment, and new payment location

Research Design Conclusions of the Global Payment Infrastructure Case Study

In sum, this study uses a case study research design. The framing of the global payment infrastructure case goes beyond a single organisation, system, country, function, or infrastructure part. Instead, the case framing starts from low-value global payments between individuals, which come to form large-value global payments and drive the collection of different data accounts. The data corpus relies on situated accounts of organisations, and these guide the collection of historical accounts and appreciative narrative accounts documenting the 1973–2030 period. Abduction principles inform the data analysis. The results of the study are six infrastructural ways for global payment, which convey movement. The following chapters consider metaphorical narratives that present the findings of infrastructural ways for global payment.

CHAPTER FIVE

Global Payment Infrastructure Development Part I

*Infra*structural ways convey movement preceding and proceeding global payment structures. Structures such as orders, tokens, standards, know-your-customer forms, enforceability procedures, risk and profit management approaches, and the physical access of global payment services take place and change with movement, which infrastructural ways convey. This chapter presents three such infrastructural ways for global payment. The first one, *Granular Homogenisation,* is the infrastructural way for global payment to be objects; it encompasses how exchange objects such as global payment orders and programmable tokens come to be and change. Granular homogenisation conveys movement as differentiating and linking global payments. This is akin to how pictures hold realities that can relate to others.

Irreversible Validation is the infrastructural way for global payment to pass as a real; it encompasses how global exchange is realised as a valid past event, for example, when funds become available on the payee side and are not changed or reversed. Irreversible validation conveys movement as authenticating and completing global payment — like lenses that assist in seeing and reflecting an otherwise changing reality. Lastly, *Ubiquitous Causation* is the infrastructural way for global payment to result from action; it encompasses how global exchange is a consequence acted for. For instance, risk approaches and the physical accessibility of services allow for global payment to take place. Ubiquitous causation conveys movement as effecting and accessing global payment — just as a performance takes place with acts and the inclusion of an audience.

Accordingly, as the following metaphorical narratives present, these infrastructural ways address the development of the global payment infrastructure with movement.

Granular Homogenisation

Every global payment involves distinct transactions across different global providers. A successful global payment entails an initial payment in a local currency, a payment for exchanging currency, and a payment for settling. These different payments are linked through messages between global payment providers and their common data formats. By differentiating and linking global payment, global payment objects, such as orders, instruments, and, most recently digital tokens, come to be and change. Granular homogenisation is this infrastructural way for global payment to be objects for global exchange, which the reader can imagine as the creation of pictures. Just as pictures hold realities that relate to others, granular homogenisation is the infrastructural way that singular payments get distinguished — and for how singular payments link to form and change global exchange objects.

For example, low-value payments between individuals in different countries begin with a payment to a global payment provider. Here, there is an obligation from the payment provider toward the individual. This payment provider also uses a bank, which also has an obligation to the payment provider. Further, the payment provider instructs one of its partners, another payment provider, on the payment to the beneficiary individual in the receiving country. Following various instructions and payments to individuals, there is a payment to settle obligations between payment providers, which takes place as a payment between banks. Following these various and different payments, large-value payments take place between financial institutions for the exchanging of one currency for another; this distinct settlement is illustrated by countries' balance of payments.

As mentioned, distinctive global payments are linked together in global payment. This linking among distinct global payments follows messaging formats. In banks, messaging formats developed with the establishment of the Society for Worldwide Interbank Financial Telecommunication (SWIFT). Among global payment payment providers, however, there are no agreed formats or standards. Instead, various communications through application programming interfaces, secure file transfer protocols (SFTP), and email illustrate different data formats in payment messaging. Similarly, different data formats and messages link the payments between providers and individuals receiving funds in payment destinations.

By no means does Figure 7 present a full picture of global payment. However, this figure serves as a reference of the infrastructural way for global payment to be objects for global exchange. There are distinct payments and links among these, which come to form and change

global exchange objects, such as instruments, orders, and digital tokens. Before proceeding to a more detailed account of this infrastructural way, it is worth noting that granular homogenisation is not fixed in space or bounded points in time, as Figure 7 misleadingly illustrates. Instead, granular homogenisation underlies such space and time, as *infra*structure does.

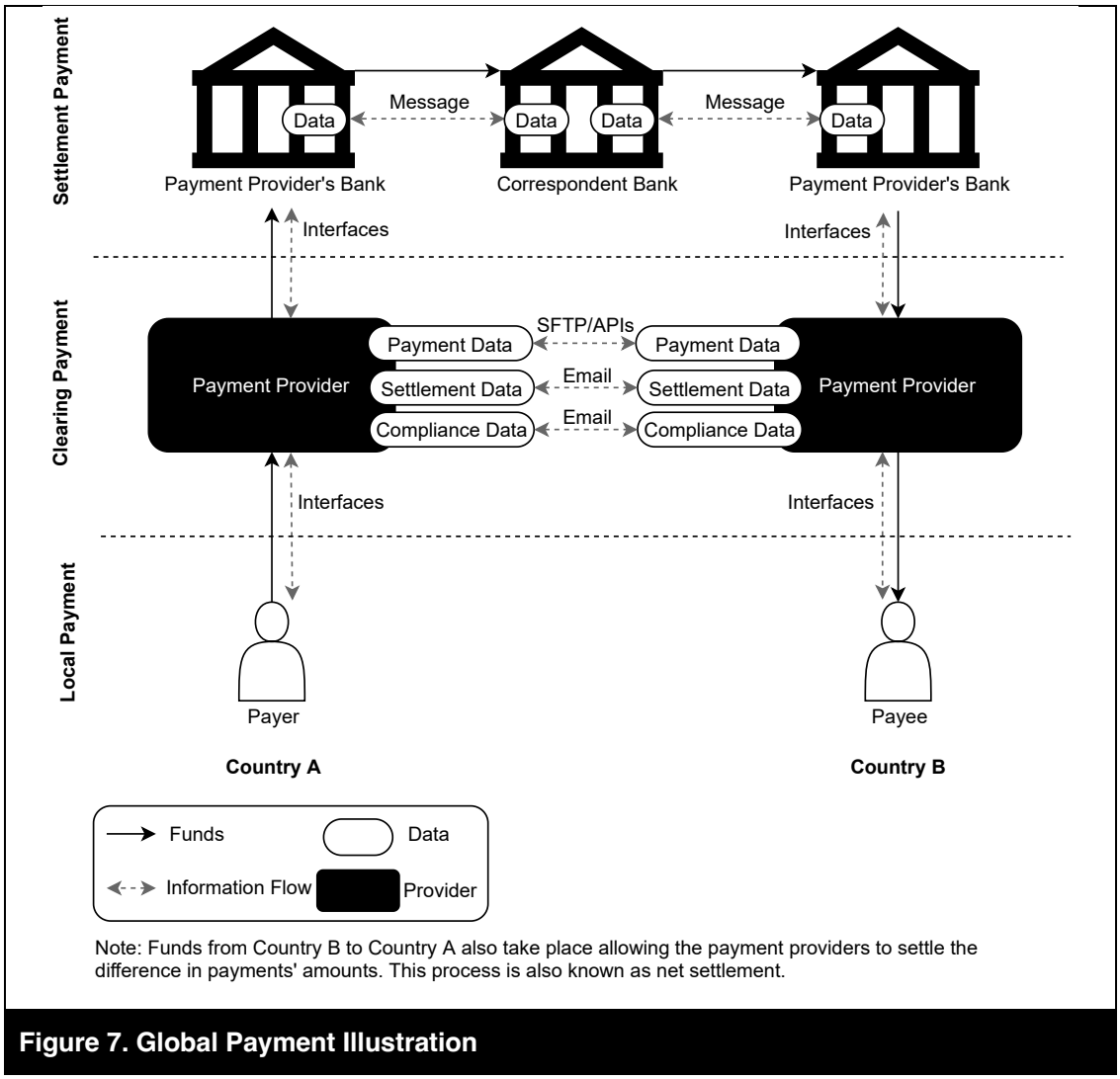


Figure 7. Global Payment Illustration

Differentiating Global Payment

For global exchange objects to be and change, there is a differentiation in global payment. Every global payment comprises distinct payments crossing different global payment providers and services. Presently, such global payment distinctions correspond with the three payments that form the three layers of Figure 7. Even though each layer could be further divided into layers, or payment types, all these subsequent layers follow the overreaching payment distinctions below.

As emphasised by an executive from a global payment organisation in the middle east, “There is a data transmission part, there is a settlement part, and there is a reconciliation part” (INTother Interview). A historical study of SWIFT (Scott & Zachariadis, 2014, p. 34; SW1 Report) describes payment stages of “1. Authorisation and initiation of the payment 2. Transmission and exchange of the payment instruction 3. Settlement of the payment.” Similarly, at QRS, global payment is initiated through a local payment, then there is a clearing payment, and then there is a settlement payment between the two providers.

Global payment involves different payments in the sense that distinctive payments come about with these facets, stages, or layers for global exchange objects to be and change. Every global payment relation presented in Figure 7 consists of these three overreaching layers, e.g., a global payment through a correspondent bank would follow the same distinctions. As a summary,

- *Local payment* is the initiation and delivery of global payment between global payment providers and people.
- *Clearing payment* is the confirmation between global payment providers.
- *Settlement payment* is the reconciliation and discharge between global payment providers.

> “The key participants in a [global payment] transfer are the sender, the receiver and the [global payment] service provider. In practice, there will often be two [global payment providers] involved, one in the sending country (the capturing service provider) and one in the receiving country (the disbursing service provider), who need to work together in some way to provide the overall service. Moreover, [global payment providers] do not always use their own offices or branches in order to provide the service. Sometimes they may make use of agents to capture or disburse funds on their behalf. Banks and other deposit-takers such as credit unions are also usually important participants in [global payment] transfers: [global payment providers] may themselves be deposit-takers but, even if they are not, they are likely to use deposit-takers to transfer the funds between countries... the sender pays the capturing agent and the disbursing agent pays the receiver...These payments can be made in a wide variety of ways depending on the service — for example, by cash, by debiting or crediting a bank account, or by use of prepaid funds like electronic money” (BIS, 2007, p. 8; BIS1 Report).

In global payment, there is a local payment for the initiation and delivery of global payment. This payment involves multiple locations associated together. Even though global payment providers serve a specific country, these providers also associate with other providers named agents, which use their software to offer a range of services in a specific location. In turn, local payment involves various agents and payment services coming together to form global payment. At QRS, for example, its partner in the Dominican Republic offers an extensive range of home delivery cash services for paying global payments. In Brazil, QRS partner primarily offers bank account deposits. Similarly, QRS agents offer cash and card services and sometimes credit services, e.g., by giving credit to recurrent clients and friends, which QRS does not offer with its services.

> "The 'location' of the transaction between the sender and the capturing agent ('access point') is usually a physical location such as a local shop, post office, bank branch, foreign exchange bureau or an outlet specialising in [global payment] services, but new technology makes 'virtual locations' such as the internet or mobile phones increasingly possible. The nature of the location affects the payment possibilities: for virtual locations, it is likely to be necessary to use card payments, e-money or credit since physical instruments such as cash or cheques are not possible" (BIS, 2007, p. 40; BIS1 Report).

Following local payments, there is a clearing payment, which involves a confirmation between global payment providers. When local payment initiates, a global payment provider sends a confirmation to its partner provider in the receiving country. Such confirmation involves details of various global payment orders, which are requests to make a global payment transfer. At QRS, the confirmation takes place in the form of a message, which outlines the funds to be credited to the payee's bank account. This confirmation, further explored in the next section, has the different exchange rates to be applied for a group of global payment orders, the pay-out method, and a commission fees to be paid to the payment service provider in the receiving country. This clearing payment in itself bundles local global payments with confirmation, which authorises the crediting and paying out of funds on the receiving country. Even though local payments are distinctive, these are grouped together in clearing payment.

> "Clearing: the process of transmitting, reconciling and, in some cases, confirming transfer orders prior to settlement, potentially including the netting of orders and the establishment of final positions for settlement" (ECB, 2009, p.5; CBEU1 Report).

> "Correspondent Banking: An arrangement in which one bank (correspondent) holds deposits owned by other banks (respondents) and provides payment and other services to those respondent banks. Such arrangements may also be known as 'agency relationships' in some domestic contexts. In international banking, balances held for a foreign respondent bank may be used to settle [foreign exchange] transactions. Reciprocal correspondent banking relationships may involve the use of nostro and vostro accounts to settle foreign exchange transactions" (BIS, 2013, p. 32; BIS56 Report).

Furthermore, local and clearing payments are reconciled and finally there is a discharge between global payment providers, a settlement payment. Commonly, there are gross settlement and net settlement approaches for global payment. Gross settlement involves the completion of a collection of orders, whereas net settlement includes orders received from a paying partner. For example, QRS' providers reconcile payment orders sent and received, and agree on the balancing amounts to be paid, the net settlement amount. Thus, global payment providers further group clearing payments, assess what is owed by each, and create a further payment with their banks to settle such balances. This settlement payment could be further expressed in the same three aforementioned processes, and there is a correspondent bank that bridges banks of different global payment providers. From the perspective of global payment providers, such settlement payment is the last payment. In practice, however, local, clearing, and settlement payments take place continuously, and QRS and its partners balance their accounts once a month by auditing their transaction records. Errors are also adjusted between payment service providers, for example, by changing differences in exchange rates and commission fees deferring in both records and by adding an error number in their accounts.

> "Settlement: the completion of a transaction or of processing with the aim of discharging participants' obligations through the transfer of funds and/or securities. A settlement may be final or provisional" (ECB, 2009, p.24; CBEU1 Report).

> "A [global payment] transfer is likely to involve a 'settlement chain' - a series of separate payments, each of which may be made differently. Payments to and from end users have already been described. For each of the payments in-between (from capturing agent through to disbursing agent), settlement will normally take place by means of a credit transfer from the payer to the payee's bank, with one of the payments being cross-border (typically by correspondent banking)[…] Unlike payments between end users and agents, where each [global payment] transfer usually requires a separate payment, the payments between agents and the [global service provider] may be batched and possibly netted (e.g., all the transfer instructions from the agent to the [service provider] that day are netted against all the transfer instructions from the [service provider] to the agent in order to create a single payment). Often, the scope for netting may be limited given the largely one-way nature of [global payment] flows; however, in some cases the flow may be sufficiently even in each direction that, after netting, the amount to be settled is small or fluctuates around zero, requiring no settlement." (BIS, 2007, p. 41; BIS1 Report).

Global payment orders, instruments, and digital tokens, or more generally, global exchange objects are and change because of differentiation in global payment, not the other way around. Differentiating global payment with distinct payments underlies global payment providers at different layers dealing with these different global payments. As Figure 7 illustrates, global payment providers offer their services while operating between settlement and local global payments. At QRS, this global payment provider partners with other providers in different countries (e.g., Colombia, Peru, Ecuador, Bolivia, Spain, Dominican Republic, Venezuela, and Russia, among others), which support local payments across diverse regulatory settings. At the same time, these different local payments are with the differentiation of further distinctive payments that partners' agents support. Various global payment providers such as QRS and its partners also are with different global payments at banks, which use SWIFT's messaging services.

Thus, the infrastructural way for global payment to be global exchange objects, granular homogenisation, conveys the differentiation of distinctive global payments. Local payment implies the initiation and delivery of payment. With these distinctions, there are multiple locations, service providers, agents, and service mediums (e.g., mobile phone applications, offices). Clearing payment implies the confirmation between global payment providers. This payment distinction underlies various global payment services that exist with the accumulation of other global payments as QRS does. Further, with a clearing payment, there is a settlement

payment, a further distinction that implies reconciling different accounts and a further payment through banking services to settle balances. Lastly, settlement payment also is with the distinctions of clearing and local payment.

Building upon Figure 7, granular homogenisation conveys each distinction made in this figure, which also follow other distinctions. Local payment, for example, may involve multiple initial payments across agents' offices. In addition, there is a clearing between global payment providers and their agents. Finally, there is also settlement with the reconciliation and discharging of balances following the transfer of funds between agents and global payment providers' bank accounts. The settlement layer, payment, in Figure 7 also follows further differentiations. There is an initiation of global payment in one of the global payment providers' bank accounts, which a clearing procedure by underlying messaging services from SWIFT addresses. There is also a culmination by a settlement payment, which realises obligations between banks, even though global payment providers may have already had their accounts credited through a clearing payment between banks. In sum, granular homogenisation implies differentiation of global payment, which hold and form realities upward and downward in singular payment distinctions, as local, clearing, and settlement payments do.

However, the infrastructural way of granular homogenisation also implies the formation and change of global payment structures. Preceding the processes presented with QRS, before the 1990s, local payments took place in cash and clearing payments by email. Further, global payment providers offering services for low-value payments were not regulated. There were no limits for how much money in cash was accepted by these global payment providers. At the same time, sending low-value payments through banks and SWIFT was very costly and time-consuming, particularly for people immigrating to countries such as the United Kingdom and European countries where language barriers and lack of documentation added difficulties.

Therefore, the development of global payment providers taking the role of QRS at the time is recalled by people part of such process as a business developed "by immigrants for immigrants" (INT2 Interview). Consequently, differentiation in global payment followed local payments in cash, while clearing payment took place through email communication. A settlement payment was performed through banks and cash. Business trips, for example, involved the transport of cash to settle accounts between partners when banks and SWIFT messaging services were not involved. Since there were no standards or automated communication, local and clearing payments took place manually at specific times during the day or with little planning.

There is some affinity with how banks would process their transactions before SWIFT establishment in 1973. There were errors even though practices for handling and controlling local payment were in place. Bags of money would be moved and deposited at bank branches, sometimes informally by workers. Settlements also took place continuously and when needed. Even though these weren't formally described as today, local, clearing, and settlement payment distinctions were present. There was ease for workers to manipulate global payment transactions data and speed up a specific transaction by a confirmation email that deviated from cutting times that would batch transactions in a single confirmation email.

The infrastructural way of granular homogenisation therefore precedes current global payment structures. Since, the early 2000s, email have been being replaced with SFTP communications giving rise to the constant batching and sending of transfers. Further, different global payment providers like QRS, and its agents, have been established by people who have immigrated to Europe and the United Kingdom from Africa, Latin America, and Eastern Europe and Russia. There has been growth in low value global payments, which is now becoming more present to people from Europe and the United Kingdom travelling across Europe, the United States, and developing countries, who are becoming immigrants. Therefore, the rise of further global payment distinctions, which also proceeds present global payment structures.

In the Philippines, for example, the use of mobile technologies and telecommunication services implies connecting locations where the distinctions between payment initiation through a text message and its confirmation by the receipt of such text message appear to blur with a further distinction. Such blurring and further distinction of local and clearing payment is also present in Africa's ample use of mobile payment applications through telecommunication channels, which began in the early 2000s. In Europe, moreover, there is a common settlement channel with the establishment of the Single Europe Payment Area services, which extends to non-Euro European countries and is driving a distinction that brings together the initiation and settlement of global payments between banks.

> "In the Philippines, two telecoms companies are competing to offer [low value payment] services that use mobile phones and e-money (stored value). Both schemes are of the negotiated network type, where to provide the service the telecoms company has recruited [payment service providers] in sending countries with significant Philippine communities. To make a [global payment] transfer, the sender pays cash to one of these partners, in return for which the [service provider] sends a secure text message to the mobile phone of

the receiver in the Philippines. The effect of this text message is to load e-money onto that phone, which the receiver can then transfer, by a further text message, either to the phone of another person or to an agent of the telecoms company. In the latter case, the agent will give the receiver cash in return. Settlement between the sending [payment service providers] and the telecoms company, and between the telecoms company and its agents in the Philippines, is via the usual banking channels" (BIS, 2007, p. 38; BIS1 Report).

Indeed, with the ample use of mobile phone applications for local payment and clearing payment, there are further global payment distinctions taking place in a common settlement channel or communication standard. In light of these differences, when global payment is initiated, funds are made available to the payee's account. Local payment is coming together with clearing payment. A differentiation, which, compared to the QRS case, seems to take place by linking distinct payments as discussed later.

Since the development of blockchain and distributed ledger technology in 2008, programmable payment instruments are being developed with global payment distinctions. Aryze, as its CEO describes, is a "full reserve bank" aiming to create "digital cash, more commonly known as stable coins." The project centres on offering global digital payment using the banking infrastructure to maintain stability in its digital token. In this process Aryze is creating its own payment service by bridging local and settlement payments. The organisation's CEO further describes the project, "we are essentially tokenising fiat bonds (…), we cannot hold dollars in the Danish national bank so if we want to issue a stable coin with dollars, we need to have a partner bank in the US (…) we need to have a partner bank [for] each currency that we support" (Aryze Observation). In other words, the organisation aims to provide an end-to-end service while using central bank bonds to provide stability to digital tokens in different currencies. This payment includes money with central bank bonds and the ownership of such money, which distributed ledger technology services confirming the transfer of ownership (e.g., Ethereum) support. Thus, there is a payment distinction that includes local and settlement payment while to some extent circumventing the use of global payment services at banks that are supported by SWIFT.

"Settlement asset. Some arrangements are based on updating balances in the ledger (that is, the ledger is recording positions through debits and credits). Some arrangements are based on transferring digital assets in the ledger (that is, the ledger is recording the transfer of ownership of a specific digital asset that exists only on the ledger). Yet other

> arrangements are based on transferring digital representations of a physical asset that is held in custody (ie the ledger is recording transfers of assets held elsewhere). In the context of a payment system, for example, an arrangement could be updating a balance, transferring digital currency or updating an account balance reflecting monies held at a custodian bank" (BIS, 2017, p. 15; BIS107 Report).

At the same time, Aryze service centres in further singular payment distinctions. The gobal payment service provider has partnered with Britannia, a bank based in the Bahamas, to store its clients' funds. Aryze also uses Ethereum to issue its token to its clients and ensure the transfer of funds between them with the use of MAMA, a Multi-Asset Modular App. With the use of Ethereum, tokens are transferred. Grant Thornton audits Aryze funds at Britannia to confirm all deposited are paid into Aryze's bank account.

This means multiple payment distinctions underlie Aryze service, which is imagined in the future by its CEO as programmable money. Other partners affiliating to MAMA can receive and pay funds across borders, while developers can use Ethereum to program distinct payments in the future. Such differentiation in global payment is also imagined by executives who recall such distinctions already taking place with different global payments within a global payment provider. Figure 8 pictures how one of the executives referred to Wise, a global payment provider, to explain how paying from Australia to India implied different global payment distinctions in terms of costs and options, which is how he imagines global payment in the future.

In sum, granular homogenisation is the infrastructural way for global payment to be objects for global exchange, which involves the differentiation of global payment into singular payment distinctions. Local, clearing, and settlement payments bring to the foreground such singular distinctions with the initiation and delivery of global payment, its confirmation between global payment providers, and the discharge of obligations through a further payment that uses banking services. Each local payment, however, also involves a payment of initiation, confirmation, and discharge. Moreover, when global payment providers settle their accounts, a settlement payment also follows payment for initiation, confirmation, and discharge at banks, which is further reflected in the countries' balance of payments.

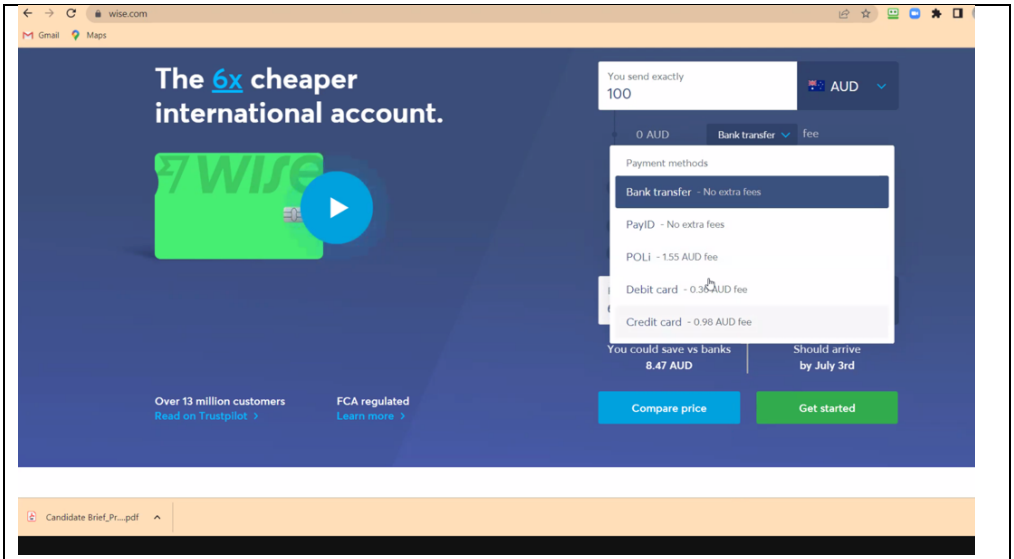


Figure 8. Picture of Future Global Payment Services Demonstration

Differentiating global payments, then, extends upward and downward as much as backwards and forward. Before the present global payment structures (and not that long ago), payment distinctions took place with cash for initiation payments, while confirmation took place by email and settlement through banking services or cash. Proceeding present global payment structures, local, clearing, and settlement payments continue. Yet, emerging global payment services are also taking place with further distinctions, which are linked within programmable instruments and in imagined global payment services in the future.

Linking Global Payments

Granular homogenisation also involves the linking of distinct global payments. Local, clearing, and settlement payments are linked through messaging in global payment. Payment messaging, in its different approaches, links different and singled out payments to form global exchange objects, such as payment orders, instruments, and digital tokens. In this sense, different messaging approaches underlie existing global payment services, which are "negotiated services, franchise services, open services, and unilateral services," according to one of the reports analysed (BIS1 Report). This report also highlights how these services relate to a type of "link" between distinctive payments.

> "[Global payment] services can be more or less complex, and of varying speed. However, in all cases it is necessary to have some kind of 'Network' - ie access points, where

consumers of [global payment] services pay and receive funds. Also needed are procedures to link those access points to enable messaging (the transfer of information…) and settlement (the transfer of the funds themselves)" (BIS, 2007, p. 2; BIS1 Report).

"Systems can be interconnected in a variety of ways. In some cases, interdependencies arise from direct relationships among systems. For example, central securities depositories and large-value payment systems may establish technical links or account relationships to facilitate efficient delivery versus payment settlement of securities transfers. Similarly, the continuous linked settlement (CLS) system depends on the account relationships that CLS Bank has established with the central banks of CLS-eligible currencies to facilitate the funding process that supports the payment versus payment settlement of foreign exchange trades across the books of CLS Bank. But, systems can also be interdependent in less direct and more complicated ways. Financial institutions that have settlement activities in several systems or that provide services to several systems can create indirect relationships among those same systems. Interdependencies can also result, for example, from the dependence of a number of systems on a common messaging service provider like SWIFT, or on a common third-party service provider for their IT systems" (BIS, 2008, p. 1; BIS2 Report).

Diverse messages underlie negotiated services, which imply negotiations between global payment providers. At QRS, for example, messaging implies data transmission through application programming interfaces (APIs) and Secure File Transfer Protocol (SFTP), which follow various .txt formats and interfaces. There is no data standard between global payment providers. The lead server supporting computing messaging varies; sometimes, it may be in one organisation or the other. The data transmitted also varies across the different providers, as some countries require more information for compliance procedures than others. Spain, for instance, requires all transactions to be with a form of identity proof such as a passport's identification number. Lastly, data transmission takes place in most cases every thirty minutes and in some cases within just a few minutes to facilitate the availability of funds.

Links in negotiated services imply diverse yet alike messaging formats. All systems integrations in QRS would follow similar data formats and similar approaches for data transmissions. However, messaging and data sharing variation also showcased segregation across the clearing payment layer. Specifically, client data for local payments was minimally shared across providers' systems. Figure 9 below illustrates that .txt files group global payment data of

different transactions to be paid out in receiving countries. These data include a header that identifies the global payment provider on the receiving end. The body includes payment data such as exchange rates, transaction fees by partners, and pay-out methods. Here, for example, senders' phone numbers and contact details would not be shared. Lastly, a footer in the file includes the total number of payment transactions shared and the total amount to be paid out.

"Record Type"|"Agent Code"|"Creation Date"

"0"|"P9"|"28/11/2014"

"Record Type"|"Transaction ID"|"Sender First Name"|"Sender Last Name"|"Sender Address"|"Sender Phone"|"Sender City"|"Sender Country Code"|"Sender Email"|"Sender DOB"|"Sender ID Type"|"Sender ID #"|"Sender ID start Date"|"Sender ID Exp Date"|"Sender Occupation"|"Receiver First Name"|"Receiver Last Name"|"Receiver City"|"Receiver Address"|"Receiver Mobile Phone"|"Receiver Country Code"|"Receiver Zip Code"|"Receiver Email"|"Receiver DOB"|"Settlement Currency"|"Service Type"|"Pay Ccy"|"Sender Branch Code"|"Payer Branch Code"|"Settlement Amount"|"Receiver Amount"|"Exchange Rate"|"Account Number"|"Bank Name"|"Bank Branch"|"Comment"|"Sender Nationality"|"Receiver Nationality"|"Transfer Costs"|"Payout City"|"Payout Country"|"Consecutive Number"|"Benefiriary ID Type"|"Beneficiary ID"

"1"|"AAA005975"|"Roksana"|"Babayan"|"Elephant and Castle"|"+448927382"|"London"|"ENG"|""|"Passport"|"AO39284"|"01/01/2010"|"31/12/2019"|""|"Cleaner"|""|"Jhon"|"Vargas"|"28 De Mayo"|"+3454345679"|"4023"|"Jhon@gmail.com"|"01/02/1995"|"EUR"|"Bank Deposit"|"EUR"|" Elephant and Castle LONDON "|"Puerta de Acala Madrid"|"145.0000"|"145.00"|"1.00000"|"95039234"|"La Caixa"|"345"|"with love, enjoy your trip son"|"Spanish"|"Ecuadorian"|"1.00"|"Madrid"|"ESP"|"6"|"Passport"|"EC21084"

"Record Type"|"Txn Count"|"Total Amount"

"2"|"1"|"145.00"

Figure 9. Example of a .txt File[26] Format Between Global Payment Providers

While negotiated services follow similar yet diverse links between global payment providers, franchise services follow a common format and messaging channel. A single operating system is lent to other global payment providers with limited rights that come under an agent category. One of QRS's partners offers a partially franchise service. This global payment provider has its services across Argentina, Bolivia, Brazil, Paraguay, Uruguay, Costa Rica and Honduras using its own system. Thus, developing a network with partnering agents that would use its payment system with defined internal messaging formats.

At the same time, this organisation partners with other global payment providers to extend its network and lend its services. For example, adding to its own network, this organisation partners with Banks and global payment services in Colombia, Peru, El Salvador, Nicaragua,

[26] Payment data in this illustration are made up.

Dominican Republic, Panamá and Guatemala. In turn, this partially franchise service accounted for most of the payout locations at QRS. By partnering with this global payment provider, following the formats of Figure 10, QRS has access to this partner's network as well as the networks of this partner's partners. It was one of the first global payment providers QRS partnered with because one messaging format, IT integration, and legal agreement included a variety of countries, services, and payout locations. Yet, with less variety in messaging when compared with its negotiated and direct links.

With time, however, QRS began prioritising partnering directly with global payment providers in South America following a negotiated approach and link. QRS aims came to be the reduction of costs per transaction, the diversification of its network, and the development of its own partially franchise service and standard to serve other networks. QRS began this standardisation with the application of Strings as data format, allowing for variation in data fields compared to more "rigid" formats following an alphanumeric or numeric-only criterion. At the same time, QRS developed a new system using Salesforce.[27] In this system, QRS began encouraging its partners to use its data formats and servers for creating transaction data messages. In so doing, QRS is developing a standard for its partners by including their requirements in improved versions of its messaging file formats.

> "So one of the most important projects that I was involved was with a company called [name of an organisation].
>
> The reason why is because they propose a solution to create a platform where all the players had to integrate directly with this platform, and by integrating with this platform, any of the players were able to send transactions or receive transactions for any of the players, so that was very interesting to see" (INT1 Interview).

[27] Salesforce is a customer relationship management system and service, which QRS used and customised for developing and scaling its services.

		Field	Description	Example
1	R	Date	Transfer date	dd/mm/yyyy
2	R	Consecutive Number	Consecutive number starting in 1	125
3	R	Reference	User reference (alphanumeric)	ST125
4	R	Amount sent	Amount sent in dollars	153
5	R	FX rate	FX rate given by partner	1
6	R	Pay-out Currency	Pay-out Currency ISO 4217 - 3 Characters	USD = Dollars UYU = Uruguayan Pesos ARS = Argentinian Pesos
7	R	Pay-out amount	Amount to be paid. It is expressed in the pay-out currency and it should have applied the FX rate	153 (if decimals, use '.')
8	-	Partner Commission	Commission to be paid to the partner	1
9	R	Sender's Name	Alphanumeric	JUAN
10	R	Sender's surname	Alphanumeric	RODRÍGUEZ
11	-	Sender's ID number	Alphanumeric	AZA153545
12	R	Beneficiary's Name	Alphanumeric	LAURA
13	R	Beneficiary's Surname	Alphanumeric	MARTINEZ
14	R	Beneficiary's Address	Alphanumeric	Av. Soca 1536
15	R	Beneficiary's City	Alphanumeric	Montevideo
16	R	Beneficiary's Country	Alphanumeric	URUGUAY
17	R	Beneficiary's Contact number	Alphanumeric	7080520
18	-	Message	Alphanumeric 100 characters max.	SALUDOS A TODOS....
19	R	Bank Name	Alphanumeric	BRADESCO
20	R	Bank Branch	Alphanumeric	154-5
21	R	Account Number	Alphanumeric	15554
22	R	Account type	Alphanumeric	CTE = Current Account AHO = Savings Account
23	-	Beneficiary's CPF	Alphanumeric	623601322-53
24	R	Pay-out office code	Pay-out offices code that the partners provides to the agent -Alphanumeric	1534
25	R	Country of origin (ISO code, 3 Characters)	Alphanumeric	e.g. Spain ISO **ESP** Italy ISO **ITA**
26	R	Sender's number	Alphanumeric	12346657
27	R	Sender's Address	Alphanumeric	
28	R	Sender's city	Alphanumeric	Madrid
29	R	Sender's ID type	Alphanumeric	DNI – PAS…
30	R	Base Currency	Base currency for the transfer ISO 4217 - 3 characters	

R stands for required.

Figure 10. Example of an Integration Document[28] Between Global Payment Providers

Differently from franchise services, open services foreground a common messaging format that is single and shared. SWIFT illustrates this messaging and service approach. Recalling the previous section's discussion on the settlement layer, multiple banks share the messaging service and standards developed with SWIFT. There is an open network available for banks at a fee, and by joining this network, banks may use existing agreements and links for offering services across the world. SWIFT is a messaging telecommunication provider and cooperative owned by banks. Thus, its only purpose is to provide the links by which data is created and shared between banks for global payment. There is homogeneity, not in service per se but in the formats and connections SWIFT allows as a common messaging format for banks. These underlying messaging and telecommunication links also involve legal bridges of correspondent banks, which serve a middle banks for regional banks and payment services.

> "In an open service, [a global payment provider] offers a proprietary service to its customers in the sending country and obtains access points in the receiving country using

[28] The integration fields are just part the message and legal integration documents of payment providers. The examples of each of the fields are invented and do not represent any personal data.

an open network to which any [global payment provider] can have direct or indirect access" (BIS, 2007, p. 10; BIS1 Report).

"cross-border links between the domestic payment arrangements of different countries. At the moment these links, which are typically needed for settling [global payment] transfers, are in most cases provided by correspondent banking" (BIS, 2007, p. 15; BIS1 Report).

Even though QRS has its own negotiated network service and is transitioning to offer its standardised network to other partners, it still made use of its indirect access to the open services supported by SWIFT. This is the case not only for a payment settlement with its partners but also for individual client transactions of large amounts at QRS, those of half a million dollars. Such large payments, deviating from the 350 USD average amount per global payment order at QRS, are manually conducted. QRS reviews foreign exchange trends for the purchase of a settlement currency, commonly United States Dollars for its partners, in exchange for local currency, commonly Great Britain Pounds for QRS. Moreover, there is coordination with the sending client to make sure that the purchase of dollars takes place on a date and time when QRS could use its bank for a global payment settlement that would reach its partner. QRS's partner also knows in advance about this transaction to effectively convert the settlement currency into their local payment currency and then deposit the funds to the payee's bank account. Albeit SWIFT's network use was primarily for specific large-value global payments and currencies, the indirect access of an open messaging and link was also primary for the existence of QRS global payment services.

Lastly, unilateral services illustrate messaging and payment services as being within a defined entity. There is an end-to-end singular link. The main difference is that these messaging links are fully internalised and not so clearly separated from the service offered, as would be the case with other services and messaging formats. For example, negotiated services illustrate messaging processes as diverse messaging formats that are alike. Franchise services illustrate a common messaging structure that is shared across various payment service providers. Open services illustrate messaging following a common format accessible to any participating provider, directly or indirectly. In contrast to these messaging links, unilateral services imply a lack of distinction between messaging and the payment service itself. Instead, the distinct payment taking place in such a provider means its message is payment itself.

> "A unilateral service is a proprietary product provided 'internally' by a single [global payment provider] without involving other entities as capturing or disbursement agents" (BIS, 2007, p. 9; BIS1 Report).

Linking different global payments is not new or present, however. The development of SWIFT as a cooperative and messaging telecommunication network took place when banks had different communication formats and messaging standards in 1973. These were diverse, albeit similar to how QRS negotiated arrangements look today. There was a need across the banking industry to have a common structure and communication channel to solve increasing manual errors by growing numbers of transactions. Therefore, there was an emphasis on setting some common formats to open ended fields recording transaction data and to automate global payment. In light of these challenges, SWIFT was developed as a cooperative owned by its banking members. This development set common messaging standards now known by SWIFT MT messaging forms. These forms were based on previous standards that followed messaging formats used with Telex telecommunication services, which SWIFT came to replace.

During these early days, global payment providers, like Western Union, expanded following their background in telecommunication, first developing a unilateral and later franchise services. With increasing global payment services to some regions rather than others global payment services preceding QRS also established by negotiating and partnering with small global payment providers circumventing large providers with the use of email. Granular homogenisation is this infrastructural way for global payment to be objects, such as orders, instruments, or digital tokens, for global exchange, which involves a linking of distinct payments.

Moving back forward, linking continues beyond present structures. As noted with Aryze, linking is taking place in services that extend towards the future and where messaging links and payment are together forming global exchange objects. For instance, Aryze imagines a a global payment platform linking different services with its digital token. In the words of its CEO,

> "In this ecosystem, I could go and buy a litre of milk in the supermarket, and the supermarket could use these funds instantly to pay their own expenses, and they could even pay out salaries in the same ecosystem. So, we will have this closed loop of transactions without money ever having to move. Not only [it does not] have to be moved, but it also doesn't have to be liquidated from the bond in which it is placed" (Aryze Observation).

Similarly, SWIFT is developing its messaging services with distributed ledger technologies to transition to sharing ledgers rather than 'sending them'. With its new service named GPI, SWIFT follows underlying ideas of further linking the creation and sharing of data across banks. Such new links are discussed under a unique transaction reference that homogenise otherwise diverse transactions and data. As described by SWIFT's head of standards in one of the observations conducted,

> "One of the things that GPI enables, in the domain of Nostro[29] [account] reconciliation, is the concept of unique end-to-end transaction referencing. This is important because [without such referencing] it becomes very difficult indeed to do the transaction-based reconciliation on the shared ledger. So, the idea that every correspondent banking transaction should be a GPI transaction, meaning it has a unique end-to-end transaction reference, is actually a prerequisite to successfully transition to sharing ledgers rather than sending them to each other" (SWIFT Observation).

The linking between banks is further encouraged by SWIFT's transition to ISO20022, which is currently taking place with the participation of central banks. As reflected by SWIFT head of standards when thinking about the spread of ISO20022, links taking place with messaging implies homogenisation.

> "The central banks and market infrastructures are all (…) exposing how high-value payments as an entire end-to-end business process work, down to the definitions and contents of each individual field. This is quite interesting. So, the central banks are actually laying down the foundations for not only harmonization but interoperability. I think it is early days to see whether [the further interoperability of global payment services] is actually going to manifest itself yet. But the central banks have decided they're going to use the same [payment] meanings, the same terms, the same templates" (SWIFT Observation).

[29] Nostro is the name for accounts banks have with other banks in a foreign currency. These accounts are common for foreign exchange and held with correspondent banks.

In sum, differentiated global payments, together with the links among such payments, underlie global payment orders, instruments, services, and digital tokens — and thus, ultimately global exchange. Messaging illustrates the linking of different payments by bringing these payments and their various formats together. As payment distinctions continue, so do their links. For example, local, clearing, and settlement payments are distinct yet all related through messaging. Similarly, as messaging takes place, so do global payments and distinctions, which then again imply further messaging for diverse distinct payments. Put slightly differently, global exchange objects take place and change with the infrastructural way of granular homogenisation. This infrastructural way conveys movement as both granularity and homogeneity in global payment, which also underlies future structures such as Aryze programmable money.

> "A multi-asset modular app [in which] everyone can make a module (…)
> A modular platform where (…) like the Chrome browser you have this extension store where you can install [the] extensions and modules that you want, and you need (…)
> We can make what we call programmable money" (Aryze Observation).

Just as pictures hold realities that relate to others, granular homogenisation is the infrastructural way for global payment to be objects. This infrastructural way underlies how global exchange objects, such as global payment orders and digital tokens, are and come be.

Irreversible Validation

Irreversible validation is the way for global payment to pass as real. Similar to how lenses help in seeing and reflecting reality, irreversible validation is the infrastructural way global exchange is realised as a valid past event. For this to happen, there are various regulations across different countries, which illustrate the criteria for creating global payment. There are licences for global payment providers, thresholds for transaction, and know-your-customer policies prior to the creation of a global payment. Similarly, regulatory practices for payment finality and safeguarding funds ensure the completion of global payment as a past event, which broadly refers to when funds become available to payees and may not change or be reversed.

There are a variety of regulatory environments and practices in global payment. As funds cross country borders, different compliance procedures are in place. For example, there are

regulations for global payment providers to offer their services and access banking accounts even if these providers are not banks. In the United Kingdom, such authorisations are granted by the Financial Conduct Authority. In Europe, there are regulatory developments with the payment service directive and the payment service directive II, both of which are regulations easing access to banking accounts by third parties. In Latin America, regulations for accessing banking accounts and offering global payment services vary across countries, but they tend to have tighter thresholds than in Europe (according to this study's data). In Africa, regulatory practices for creating global payment vary widely but, overall, are less strict. And globally, know-your-customer practices differ plenty from provider to provider and from country to country. Some countries, for example Spain and Brazil, require beneficiaries' identification numbers for each transaction, while other countries, for example Nigeria and Ecuador, focus on threshold limits before requesting personal information. Overall, various regulations underlie how global payment is created by authenticating organisations, transactions, and people.

The completion of global payment has its own set of regulations. Such completion comes with capital requirements to protect people's funds and with regulatory demands that global payment funds not change or be reversed. For example, regulations demand capital for each global payment transaction initiated, which comes with the licensing offered to payment providers. Such capital requirements are with the rationale of ensuring that global payment funds are delivered or refunded in case of liquidation. Along with these capital requirements are governance procedures for the completion of global payment. Agreements between global payment providers state the conditions under which a global payment transaction is to be completed or held. Regulators also guarantee the completion of global payment by defining its irreversibility, that is, codifying the finality of settlement.

These regulations for the creation and completion of global payment illustrate the infrastructural way for global payment to pass as real, for acknowledging global exchange as a valid past event. For example, regulations for authenticating and completing global payment ensure (or at least aim to ensure) that funds available to payees are not changed or reversed. Such regulations follow a variety of regulatory regions and the need for unchangeability and irreversibility of funds. Irreversible validation is the *infras*tructural way for global payment to pass as real, which is not bounded in space and time but instead precedes and proceeds present regulating structures for authenticating and completing global payment as past events.

Authenticating Global Payment

Authenticating involves the validation of organisations, transactions, and people's rights and identities across countries for the creation of global payment. Such authentication involves multiple countries and is varied. QRS, for example, is an authorised payment institution by the UK's Financial Conduct Authority. In line with this authorisation, the global payment provider is allowed to receive funds deposits and pay. To maintain this right, QRS must identify and report suspicious global payment transactions, have robust know-your-customer practices, audit its global payment transactions, and have funds safeguarded for all the transactions the provider carries.

> "Identification is needed to correctly link payers and payees and to ascertain their respective account histories" (BIS, 2018b, p. 4; BIS4 Report).

> "A key form of regulation is for anti-money laundering and terrorist financing purposes and involves 'know-your-customer' requirements and recording/reporting of individual transactions (particularly large or suspicious transactions). Particularly for these purposes, many countries require [global payment providers] to be registered or licensed" (BIS, 2007, p. 16; BIS1 Report).

Yet, authentication for the creation of global payment takes place beyond QRS' licence and practices following the UK's financial services regulator. Every time a new customer comes to one of QRS offices to initiate a global payment, there is an authentication procedure. This procedure for validating people varies depending on the total funds to be paid. For global payment transactions below 850 Great Britain Pounds, QRS is not required to have a copy of a valid identification document registered in its records. However, QRS may be required to request the identification number of the payee or the sender depending on the receiving country. In Brazil, for example, the CPF number, Cadastro de Pessoas Físicas, a tax identification number is required of all payees.

Furthermore, QRS partners in other receiving countries may reject orders of less than 850 Great Britain Pounds from the United Kingdom. These global payment providers in receiving countries may require further documentation for the authentication of people following their pay out limits. As pay-out providers need to fulfil their local regulations, they have limits for paying

out funds, which them to follow up and report structuring approaches for money laundering. That is the splitting of large funds into smaller funds distributed across various people who would send funds to a receiving country and then bring such funds together to finance illicit activities.

> "First, despite 'globalization,' domestic banking systems and regulatory regimes around the world remain remarkably national" (BIS, 2006, p. 4; BIS126 Report).

This means in line with the authentication of QRS with a license and of people with know-your-customer practices, there is an identification of transactions. Some partners require people to provide a code to identify a transaction at the receiving location. In contrast, others only request payees' names and identification documents, without no request for a transaction code, to pay the funds. Moreover, when QRS customers send certain amounts of funds over a monthly period, more documentation is shared following transaction thresholds. After global payment orders exceed 850 Great Britain Pounds, QRS requests a copy of a valid identification document. When these exceed 1,500 Great Britain Pounds, proof of address and a signed declaration stating the origin of funds and the purpose for sending these are required. When global payment orders exceed 2,500 Great Britain Pounds, proof of funds in the form of payslips and bank statement records are needed to create a transaction. In some receiving countries like Colombia, however, people are generally not allowed to receive more than 5,000 United States dollars unless the paying out partner is a bank.

> "The Minimum Standards for the supervision of international banking groups and their cross-border establishments, issued by the Basel Committee on Banking Supervision in July 1992, establishes four main principles:
> 1. All international banks should be supervised by a home country authority that capably performs consolidated supervision.
> 2. The creation of a cross-border banking establishment should receive the prior consent of both the host country and the home country authority.
> 3. Home country authorities should possess the right to gather information from their cross-border banking establishments.
> 4. If the host country authority determines that any of these three standards is not being met, it could impose restrictive measures or prohibit the establishment of banking offices" (BIS, 1996, p. II; BIS30 Report).

In addition to identifying people and transactions, authentication also takes place an between global payment providers for the creation of global payment. Before offering its services, QRS negotiates and signs a contract with global payment providers in receiving countries. There is a profit assessment of the estimated total funds between global payment providers, a financial assessment and review of statements, and the identification and assessment of providers' shareholder. Following this due diligence, negotiations of credit or prefunding amounts also are defined in legal agreements. This authentication culminates in the signature of an agreement and subsequently the initiation of global payment services to that specific region.

Such due diligence process also takes place when global payment providers partner with banks to open bank accounts. Since 2006, for example, QRS used to have a bank account with B-Bank.[30] To maintain its bank account, the global payment provider was audited by B-Bank and data of specific global payments was requested to verify compliance procedures were carried out. Following the listing of global payment providers as high-risk institutions, however, B-Bank closed QRS bank account in 2013. Together with charity and gambling institutions global payment providers as QRS were identified by European regulators as a high-risk, meaning these providers are subject to risk of conducting some form of illicit activity such as money laundering. In turn, after 2013, QRS partnered with a different payment provider to receive customer funds and then opened up a bank account in Eastern Europe through its parent organisation, a bank.

> "In some countries, certain types of institutions that are potential [global payment providers] (eg non-bank deposit-takers such as credit unions) may be prohibited from providing [global payment] services, making such markets less competitive than they could be. Fees for licensing or registering [global payment providers] may be too high and used mainly as a means of raising additional government revenue. Finally, [global payment] services per se do not involve deposit-taking as it is usually defined in legislation and they usually provide only a minority of a sender's overall payment needs; applying heavy prudential requirements to [global payment providers] may therefore be disproportionate, particularly since, as discussed below, the failure of [a global payment provider] is unlikely to cause systemic risk" (BIS, 2007, p. 17; BIS1 Report).

[30] This is a fictitious name.

> "Perhaps more serious are cases where non-bank [global payment providers] face undesirable obstacles to indirect access to the payment infrastructure - ie where banks are reluctant to offer payment services to non-bank [global payment providers] or will only do so under unduly onerous conditions… Banks may have concerns about their ability to comply with regulations when their customers are [global payment providers] and may therefore decide it is preferable to simply not provide services to them" (BIS, 2007, p. 18; BIS1 Report).

The identification of global payment organisations, transactions, and people across countries illustrates authentication underlying the creation of global payment. Nonetheless, authenticating global payment also took place before QRS. Since the creation of SWIFT, the Financial Action Task Force (FATF), a global regulator, has been involved in identifying senders in global payment orders. In the 1990s, such identification needs came drove the identification of senders in SWIFT messages. Outside banks, global payment providers didn't require to have the identification of senders and there were no threshold limits for global payment orders "in the early days" because "the industry didn't exist in the regulators eyes" (INT9 Interview). Yet, for risk reasons, as discussed later, global payment providers would still identify transactions and senders.

From the terrorist attack of September 11, 2001, in the United States where four coordinated attacks took place, authenticating global payment continues today while also proceeding present regulations. As QRS illustrates, the identification of high risks organisations by the United Kingdom government implied the closure of bank accounts, which continues today under the label of de-risking. Such identification meant QRS uses alternative payment services and a different bank account in Eastern Europe. By focusing on specific organisations and leaving others "outside," the identification of high-risk organisations meant alternative operations for QRS, artificial cheaper services based on illicit payment channels for other providers, and some closed. And as countries continue to regulate, further identifications of what lies outside the framework are constantly being developed in a movement for validating what is not validated.

> "The supervisory arrangement for international banks that emerged out of the Basel process was not based on multilateral surveillance but rather on the cornerstone of home country control; that is, the idea that every financial institution should have a 'home

supervisor,' and that, as Blunden suggested, no institution should escape supervision" (BIS, 2006, p. 7; BIS126 Report).

For example, as QRS came to use a different payment provider service to deposit its clients' funds in a bank account outside the United Kingdom, distinguishing and identifying low-value payments becomes problematic. Following QRS cash or electronic deposits to its payment partner bank account, QRS instructs this partner in the United Kingdom to make a single payment. Funds then reach QRS bank account in Eastern Europe and are exchanged from Great Britain Pounds to a common settlement currency widely used by its other partners. These usually are United States Dollars and Euro, which facilitate the transfer of funds through banking channels and SWIFT. As a corollary, the identification of high-risk organisations came with the use of an alternative payment service and difficulties in identifying some low-value global payments.

"From the point of view of those providing [global payment providers], [any] transfer will often be indistinguishable from any other low-value cross-border transfers, including small payments to and from businesses (because the [global payment provider]) is unable to reliably identify that they are person-to-person)" (BIS, 2007, p. 2; BIS1 Report).

"Wire Transfers: Countries should take measures to require financial institutions, including money remitters, to include accurate and meaningful originator information (name, address and account number) on funds transfers and related messages that are sent, and the information should remain with the transfer or related message through the payment chain" (BIS, 2007, p. 25; BIS1 Report).

Following this background, the infrastructural way of irreversible validation precedes and proceeds present regulations for authenticating global payment, which underlie the valid creation of global payment. As MakerDAO illustrates, authenticating also is taking place in new and future digital global payment services. MakerDAO is developing what the organisation calls a "stable coin." With the use of Ethereum, MakerDAO provides stability to digital tokens using smart contracts that incentivise the purchase and sale of such token when its price deviates from the 1:1 value ratio with the United States Dollar. In principle, the stabilisation of these blockchain-based digital tokens follows a price validation with an existing currency. There is an exchange between an accessible cryptocurrency, such as Ethereum's Ether, for the creation of DAI, which is then

kept until DAI is liquidated. The pricing relation with the United States Dollar is maintained through the identified participants in the network. These participants are, "Maker Governance" token holders who approved changes in incentive, risk, and liquidation programs following a voting mechanism and token, which also is based on Ethereum's blockchain. "Keepers" purchase and sell DAI following price changes in relation to the United States Dollar. And "Oracles" who are individual providers of price data, which is shared for the creation of the price information underlying the incentive for the purchase or sale of DAI. Along the validation of such participants, there is the Maker foundation, community, governance facilitator, and risk management, which support various parts of the price stability processes and are mediated through governance changes following voting procedures Maker governance token holders have to follow.

Further, by using Ethereum, data of DAI and MakerDAO's governance token is created through the validation of transactions and users. Through frameworks such as "consensus mechanisms," validation of data creation takes place after it is shared across participants. For example, a payment is not acknowledged as real until it is validated across multiple user groups. In this sense, there validation of all that is not validated, organisations, transactions, and people.

> "Validation: each validator identifies state changes that are consistent according to the rules of the arrangement (that is, assets are available to the originator, and the originator and beneficiary are entitled to exchange the assets). In order to do so, each validator needs to rely on a record of previous states, either as a 'last agreed state' or as a 'chain of previous states'" (BIS, 2017, p. 4; BIS107 Report).

> "Cryptographic tools, such as public key cryptography and public key infrastructure, play an important role in DLT by identifying and authenticating approved participants, confirming data records and facilitating consensus on ledger updates" (BIS, 2017, p. 4; BIS107 Report).

Against such a background, MakerDAO's head of product describes the organisation as "one of the oldest Ethereum projects. And it has evolved from being a community project aimed at creating a stablecoin, into really now also [having] a legal structure and a team of employees and contractors." The creation of rules integrated across multiple parties through smart contracts enables a regulatory arrangement further described by the company's head of product as "creating a central bank on the Blockchain."

> "A notable property of DLT is the distribution of responsibilities for updating the ledger by multiple nodes. These nodes can be deployed across multiple sites, institutions or even jurisdictions" (BIS, 2017, p. 3; BIS107 Report).

> "the borderless online nature of digital currencies, and the absence of an identifiable 'issuer' of the instrument, pose particular challenges to attempts at regulation that a national authority might make (although other identifiable third-party providers might be more easily regulated). Borderless, online and generally unregulated systems do not involve layers of correspondent banks and can potentially make transactions faster, more convenient and feasible at lower cost. On the other hand, these types of system have also raised important concerns by law enforcement authorities about the use of these systems for illegal activity, as well as compliance with [Anti Money Laundering or Combating Financing Terrorism] obligations that apply to traditional payment methods and intermediation" (BIS, 2015, p. 10; BIS3 Report).

Thus, irreversible validation implies the creation of global payment with movement for the authentication of organisations, transactions, and people across multiple countries, extending beyond present regulations. However, this infrastructural way for global payment to pass as real also involves regulations and practices for completing global payment. The valid creation of global payment comes with its acknowledgement as a past payment event, in a similar way to how lenses help in seeing and reflecting reality.

Completing Global Payment

The creation of global payment through the authentication of organisations, transactions, and customers also entails regulatory practices for completing global payment. This means the assurance of payment completion through finality and safeguarding.

- Finality comes when global payment transactions can not change or be reversed.
- Safeguarding is for funds being fully paid out or refunded in case of a provider's liquidation.

Each global payment order created across banks using a common system, such as the European TARGET system, involves the enforceability of the transfer of funds and the irrevocability of their settlement. Enforceability implies that the transfer of funds may not be reversed, as there is a legal liability for its completion. Similarly, irrevocability means that a global transfer of funds cannot change or be cancelled once it is credited to the receiving bank or customer. Thus, global payment comes to pass as a past event. However, as global payment generally implies crossing regulatory environments with different currencies and services, completing global payment necessitates the enforceability of contracts across jurisdictions. At QRS, legal contracts with its partners in receiving countries are negotiated with the aim of having United Kingdom regulations settle disputes, even though such agreed upon jurisdiction varies from partner to partner.

> "a settlement or transfer is final when it is unconditional, enforceable and irrevocable, even in the framework of insolvency proceedings opened against a participant (except in the case of criminal offences or fraudulent acts, as determined by a competent court).
> In the European context, a distinction is made between:
> 1) the enforceability of a transfer order which is binding on third parties and protected from insolvency risks, provided that the transfer order was entered in the relevant system, in accordance with the rules of that system, prior to the opening of insolvency proceedings (with transfer orders entered in a system following the opening of insolvency proceedings being legally enforceable only in exceptional circumstances); and
> 2) the irrevocability of a transfer order which cannot be revoked by the participants as of the point in time laid down in the rules of that system. A distinction should be made between the finality of the transfer order and the finality of the transfer, which indicates the moment at which entitlement to the asset in question (be it cash or securities) is legally transferred to the receiving entity" (ECB, 2009, p.12; CBEU1 Report).

Furthermore, there is no common regulatory framework for the irrevocability of global payment between QRS and its partners, so there is some flexibility for changing global payment orders, even after the transfer of funds. Not only is global payment is final at QRS with the crediting or refunding of funds, but with the agreement of balances between the provider and its partners. For example, QRS' customers can change how the funds are to be paid out (e.g., cash, bank deposit), to whom these would be paid out, and to cancel their global payment order.

However, such changes and finality also vary across QRS providers as these have different policies. In cases when the pay-out providers are banks in Latin American countries, such as Colombia or Ecuador, QRS manages changes by cancelling the global payment orders and creating new ones with a different exchange rate.

> "The [global payment] industry, like any other, is likely to flourish best when the general legal framework in which it operates is sound, predictable, non-discriminatory and proportionate. Particularly important here is likely to be the enforceability of contracts, especially when the parties to the contract are in different jurisdictions. This is a significant issue, largely outside the scope of this report, but one that is worth emphasising because in a number of countries such a framework does not yet exist" (BIS, 2007, p. 16; BIS1 Report).

In addition, QRS does a net settlement approach. This means QRS agrees balances with its partners where further changes to global payment orders take place before these are acknowledged as completed, as a past global payment event where funds were transferred to an end consumer for a defined cost and with a defined exchange rate. For example, when there are differences in exchange rates applied for single orders, these are negotiated and agreed upon, making some loss or gain for the global payment providers without changing the crediting of funds to end consumers. Following these monthly negotiations and agreements, there are no further changes.

Such finality is similar for the banking services QRS uses to make a settlement payment to its partners. For example, QRS instructs its bank to use the SWIFT MT 103 form to create a global payment order and can also request a cancellation instructing its bank to send an additional MT 192 form. However, such cancellation requests are usually avoided as they delay the crediting of funds at QRS and its partners, affecting QRS' working capital for the company to do its operations. Usually, banks follow cut-off times for the processing of global payment orders and their requests, meaning that these remain idle until specific times when a batch of orders is processed. And when an order or request arrives at the bank after such cut-off times, it remains idle until the next working day. Thus, the global transfer of funds reach their finality before any changes, or if a cancellation is applicable, it may take days for funds to be credited at QRS bank account.

> "A key factor in determining a unilateral payment cancellation deadline is the latest time a correspondent guarantees to satisfy a cancellation request (the guaranteed cut-off time). Service level agreements should identify this cut-off time. In instances where an agreement may not specify a guaranteed cut-off time or a bank may not have a written agreement, the bank and its correspondent should establish a specific cut-off time as late as practicable" (BIS, 2013, p. 13; BIS56 Report).

In addition to the finality, funds are safeguarded to ensure their completion. Safeguarding illustrates a regulation for funds being fully paid out or refunded in case of a provider's liquidation. QRS regulatory license, for example, requires the safeguarding of funds. As QRS is an authorised payment institution licensed by the Financial Conduct Authority in the United Kingdom, it needs to keep the funds of each payment order on a separate account until this is paid out, a segregated account. Such a regulatory requirement follows the rationale of protecting people against the financial default of global payment providers. This means QRS continuously looks after its working capital balances, negotiates credit with its partners, and requests its investors funds for its segregated account. As a result of such safeguarding requirements, QRS operations centre on speeding up the deposit of cash transfers made by its customers into its bank account, planning when to conduct settlements, and negotiating credit with its partners.

Broadly, the completion of global payment as a past event implies the transfer of funds does not change and the protection of funds for their completion. However, completing global payment extends backwards and forward. Since 1970s global payment providers and banks have been doing reconciliation of accounts and developing agreed procedures and policies for not changing the transfer of funds. These procedures and policies also involved the correction of errors after funds were credited payees, due to lack of standards and manually doing orders. Before the establishment of SWIFT, for example, payment orders were sent in open text formats, without a standard, between banks. The completion of the transfer of funds would then take after the crediting of funds. At global payment providers in the 1990s these procedures were similarly done, through email and then reconciliations, meaning many changes would take place in global payment orders before the completion of payment.

However, safeguarding funds was not required at the time. In some cases, funds were stolen with global payment providers closing. Contracts between global payment providers were build based on closed relationships maintained through business trips. In the United Kingdom and

Europe, since 2010, safeguarding of funds was established as a regulation implying higher operating costs for many global payment providers and the closing down of some. Furthermore, since the introduction of regulations for safeguarding funds and the emerging practices for their finality, the completion of global payment is more clearly together with its creation, with its authentication.

MakerDAO, for example, is developing its stablecoin through the identification of price changes against the United States Dollar. However, such authentication is taking place through the design of smart contracts that account for the finality and safeguarding of funds. Once an order is created, it is not changed. The order is created and completed as it goes through and is recorded in the Blockchain, or is rejected by Ethereum's network follwing MakerDAO's smart contracts, which define the criteria for authenticating and completing global payment.

MakerDAO has pre-established procedures for creating its stable coin DAI based on the crediting of funds with another cryptocurrency, which is locked into a smart contract to safeguard DAI. When the value of DAI deviates from its pair value with the United States Dollar, the smart contract is automatically executed for liquidating DAI, or alternatively, more DAI is created. This procedure is supported by liquidity providers incentivised to buy and sell DAI. Thus, when an order between DAI users takes place, the transfer of funds follows pre-established criteria while price is kept stable and paired with the United States Dollars. Ethereum's Blockchain and its smart contracts serve for the authentication of organisations, transactions and end users public keys, and at the same time completing, with finality and safeguarding, DAI fund transfers.

> "Agreement on ledger updates: nodes agree to state changes to the ledger. This stage of the consensus process involves mechanisms or algorithms that resolve conflicting changes to the ledger. The key challenge is to ensure that valid changes are made once and only once, by ensuring that state changes are synchronised across the distributed ledger…For example, because of the distributed nature of the arrangement, it is possible that a participant transfers an asset it holds to another participant while simultaneously attempting to transfer the same asset to a third participant. Without a mechanism for agreeing which transaction to post to the ledger, the arrangement would enable participants to 'double-spend' assets" (BIS, 2017, p. 4; BIS107 Report).

In sum, authenticating and completing global payment implies the identification of organisations, transactions, and people, and it also involves the finality and safeguarding of funds

transfers so that they cannot change or be reversed. What passes as valid, through authentication, passes as real, through completion. The multiple regulatory environments for authenticating global payment and practices to assure its completion means that global payment passes as a valid past event. Irreversible validation is the infrastructural way global exchange is realised as a valid past event, which extends beyond present infrastructural change. Instead, this infrastructural way conveys movement as both authenticating and completing global payment, which underlies emerging and future structures such as MakerDAO's distributed governance for DAI creation and transfer.

> "Some DLT arrangements go a step further and allow for 'automated contract tools' which permit users to include self-executing code on the ledger to automate the fulfilment of contract terms. Examples include the execution of interest and principal payments on certain dates, collection or distribution of funds based on certain events occurring or automatic termination of contracts based on agreed upon terms. This type of functionality is often referred to by the industry as a 'smart contract'" (BIS, 2017, p. 3; BIS107 Report).

> "Regulatory issues for digital currencies based on distributed ledgers cover three main fields: consumer protection, prudential and organisational rules for the different stakeholders, and specific operating rules as payment mechanisms (e.g., settlement finality as in EU regulation)" (BIS, 2015, p. 12; BIS3 Report).

As lenses help in seeing and reflecting a moving reality, irreversible validation is the infrastructural way that global payment passes as real. This infrastructural way underlies how global exchange is realised as a valid past event, for example, when funds become available for payees and cannot be changed or reversed.

Ubiquitous Causation

Lastly, for now, ubiquitous causation is the infrastructural way for global payment to result from action. Like a theatre performance with acts and the inclusion of an audience, ubiquitous causation is the infrastructural way for global payment exchange to result as a consequence acted for. This means that global payment is effected and accessed. Cashflow liquidity, price margins, and data transferring allow for effecting the transfer of funds, which generally means managing

risks in global exchange through predictability, allowing the transfer of funds to occur. Similarly, payment channels, partnering, and network connections allow for physical access to global exchange, which results in the global transfer of funds.

Global payment involves different risk approaches that foster predictability. For example, global payment providers follow different time zones when settling with each other, which subsequently influences when funds are available and even if the payment takes place (as cash may not be available). Further, constant price fluctuations drive and constrain global payment providers' profits. To address these inherent risks, global payment providers apply margins to exchange rates, allowing them to set a day price and carry on with global payment services. Along with the application of margins, transferring data such as price and margins facilitates predictability and allows global payment to happen. Thus, global payment results as a consequence of the risk management of cashflow liquidity, margins, and data transferring, all of which effect the transfer of funds through predictability.

At the same time, for global payment to result, there needs to be accessibility, which broadly refers to global exchange reaching far distances in various forms. Consider payment channels in the Dominic Republic, where it is common to have cash home delivery services in addition to cash pick up and bank account payment services. Partnering between global payment providers and finding such partners is another illustration of how global exchange reaches far distances. Similarly, connecting existing payment processing networks widens reachability. Thus, global payment results as a consequence of payment channels, partnering, and network connections, which together improve accessibility by extending payment along far distances.

As further discussed below, effecting and accessing global payment give a sense of the infrastructural way that global payment results from action, meaning global exchange is a consequence of predictability and of physical presence. For example, for global payment to take place, risk approaches serve to define prices and to make funds available. At the same time, physical accessibility implies funds are transferred. Ubiquitous causation is the *infras*tructural way, not bounded in space and time, for global payment to result from action as a consequence effected and accessed.

Effecting Global Payment

Margins, cashflows, and data transferring are different risk approaches effecting global payment. As global payment involves multiple currencies, foreign exchange transactions take place before

the delivery of funds. Further, global payment involves the movement of funds across long distances where different opening hours for exchange and settling funds drive different risks. Accordingly, global payment providers use margins, increase their cashflows, and transfer data to effect global payment. More specifically,

- ∞ Margin is an added fee in exchange rate prices.
- ∞ Cashflow is the available flow of funds.
- ∞ Data transferring implies the creation of information for the transfer of funds.

> "A [global payment] transfer will usually involve a foreign exchange transaction - typically conversion from the currency of the sending country to the currency of the receiving country. To know the total price of the transfer, the sender needs to know the exchange rate that will be used since different [global payment providers] are likely to use different exchange rates, which vary from day to day. In practice, [payment providers] typically charge senders an exchange rate that includes a margin above the current interbank or wholesale market rate. In part, the margin may reflect the uncertainty the [payment provider] faces" (BIS, 2007, p. 11; BIS1 Report).

At QRS, for example, the management of foreign exchange rates is a central part of the provider's service. QRS buys and has reserves of a settlement currency, which would be a currency easy to globally sell and buy, such as United State Dollars (USD) and Euro (EUR). This means QRS sends and receives from its partners United States Dollars and Euros in settlement payments. In addition, QRS receives from its partners an exchange rate between the pay-out currency and the settlement currency. For example, between United State Dollars and Colombian Pesos (COP). Together with this rate by its partner QRS uses the rate for its settlement reserves, for instance a between its British Pound Sterling (GBP) and United States Dollars (USD), to define a rate for its global payment service from the United Kingdom to Colombia.

As Figure 11 illustrates, all these exchange rates include a margin, an added fee in exchange rate prices. At QRS, margins aim for profitability, allow the company not to lose profits with foreign exchange fluctuations, and to compete in terms of price with other global payment services providers in the United Kingdom. Further, QRS has a weighted rate between the British Pound Sterling and settlement currencies, which changes after purchases of settlement currencies and after settlement payments with its partners. This weighted rate, also called the settlement rate

at the organisation, serves as a reference for defining prices and making further purchases. The settlement rate also allows QRS to determine exchange rates for its customers, as prices constantly change. All these exchange rates provided by QRS' partners and participating banks and intermediary partners offering bank accounts have margins, which allow for defining exchange rate prices and more generally for effecting global payment.

> "Even if individual [global payment providers] are fully transparent, it may not be easy for end users to compare the price of different services. This is partly because market exchange rates constantly change, different margins may be applied to different currency pairs (eg to reflect differences in their volatility) with these margins changing from time to time (eg as volatility changes), and the margins may be added to different 'reference' rates (eg open market rates at different times of the day). Thus, the cheapest [payment provider] on a given day in a given currency pair may not be the cheapest on a different day or in a different currency pair" (BIS, 2007, p. 12; BIS1 Report).

In addition to margins, the liquidity of cashflows allows for the transfer of funds that otherwise would not be possible without such working capital. In the case of QRS, cashflow liquidity occurs through an initial investment from the organisation's shareholders and negotiations with payment providers in receiving countries. There is prefunding and crediting taking place between global payment providers. Therefore, when QRS receives a payment initiating a global payment order, its partners already have funds from QRS and can pay them out without receiving the same funds a payer used for initiating the global transfer of funds. Alternatively, QRS partners may offer a credit channel, which also serves the execution of global payment.

> "some [global payment providers] offer an almost immediate service - within a few moments of the sender initiating the [global payment], the receiver can collect the funds. That could be possible in this example (where, as part of the negotiated network, information flows immediately from [and to payment providers]), provided that [one of the payment providers] is willing to pay out the funds [in advance]" (BIS, 2007, p. 12; BIS1 Report).

> "If SWIFT were unavailable for a sustained period of time, a large number of other systems would be affected. If [continuous link settlement bank] faced operational difficulties, liquidity flows within several large-value payment systems could be disrupted" (BIS, 2008, p. 32; BIS2 Report).

The transferring of data, lastly, also allows for the global transfer of funds to take place. Data transferring implies sharing price, transfer statuses, and compliance data between global payment providers and organisations to plan and predict settlement payments across different time zones. Such data transferring effects global payment and shapes the speed of the global transfer of funds. As global payment implies different countries, a large transfer of funds unpaid for some time affects the cashflow of global payment providers. If funds are not quickly paid out, QRS, for example, stops having funds for continuing its global payment services. Thus, global payment providers share price data and statuses of global payment orders to facilitate the pay out or cancelation of global payment orders, or settlement payments between the providers. Furthermore, global payment providers also share their foreign exchange prices to define prices for their services, and compliance data to facilitate the pay-out of funds being held. This sharing of data also effects global payment.

> "The whole process may take a significant time. That depends in part on certain fixed schedules (eg the speed of the different payment systems involved) and on the speed of each of the parties to the transactions (eg when [a bank] receives the payment instruction from [another bank], how quickly [the next bank] passes it on to [the pay-out provider])" (BIS, 2007, p. 12; BIS1 Report).

> "Richer data also open up the prospect for greater payment flow automation and efficiency gains in cash management. The quality and availability of payment data used to monitor cashflows, manage treasury risks and reconcile balances is currently diverse, and can depend on the ability to include richer information in payment messages, which relates to the standards used" (BIS, 2019c, p. 7; BIS53 Report).

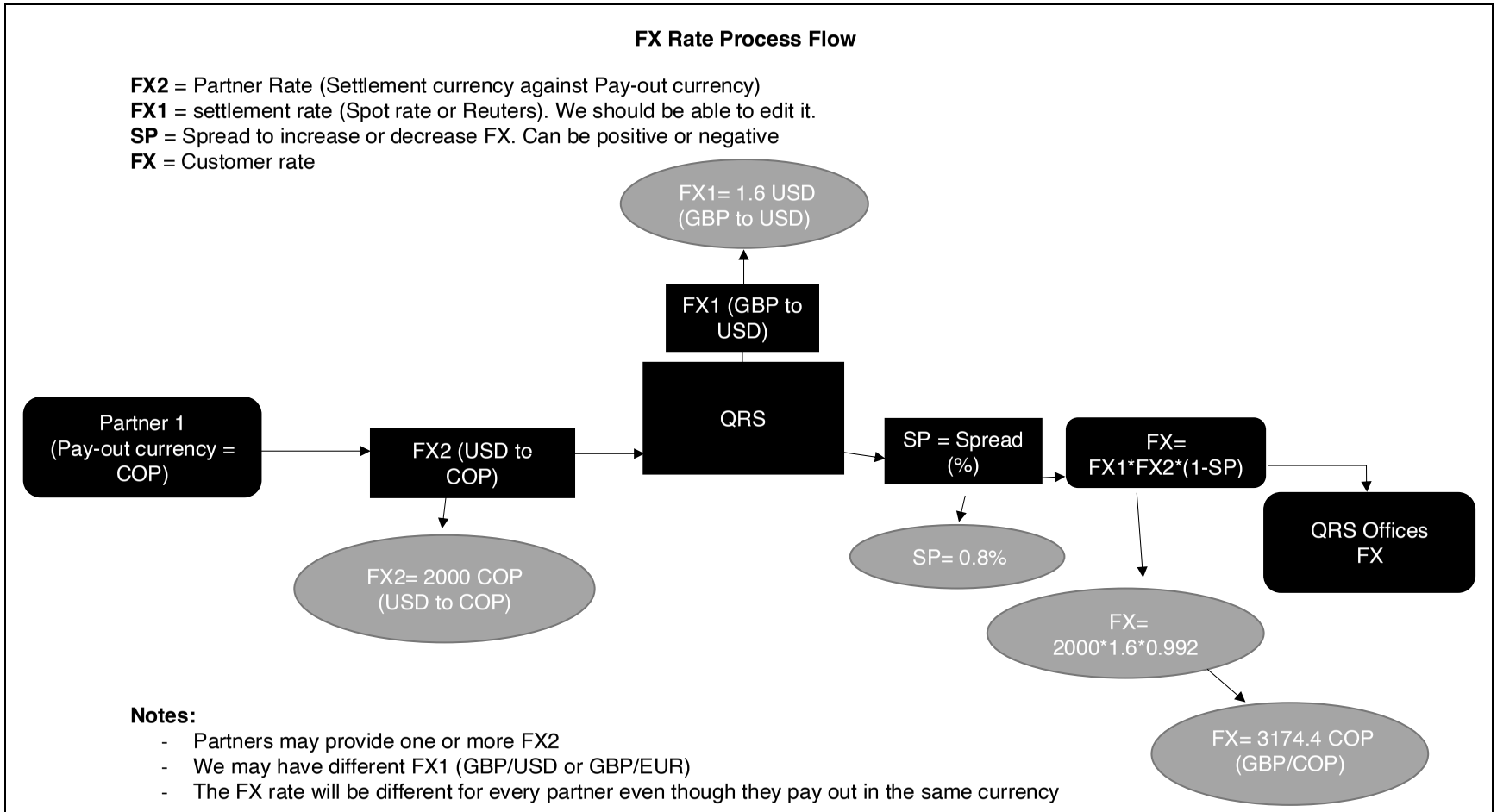


Figure 11. Example of Technical Requirements Documents at QRS

Effecting global payment with the predictability given by margins, cashflows, and data is not just present in QRS. There is and has been an ongoing discussion around straight-through processing to improve speeds in global exchange, which follow margins, cashflows, and data transferring. As exchange rates are unknown or undefined and temporal gaps exist between different payment providers operating hours, effecting global payment and increasing its speed take place through risk approaches that allow for predictability.

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processing to improve speeds in global exchange, which follow margins, cashflows, and data transferring. As exchange rates are unknown or undefined and temporal gaps exist between different payment providers operating hours, effecting global payment and increasing its speed take place through risk approaches that allow for predictability.

> "The need to conduct foreign exchange transactions adds complexity and risk for [global payment providers]. These additional complexities need to be managed and the risks mitigated, which can increase costs (in ways that are neither transparent nor predictable) and reduce the speed of an overall transaction. Another factor that poses challenges to the fast and efficient processing of cross-border retail payments is the different time zones and resulting diverging opening hours of payment systems around the world" (BIS, 2019b, p. 4; BIS51 Report).

At the end of the 20th century, for instance, cashflows implied extensive management of cash transactions, margins were higher, and there were tighter schedules for the processing of transactions by correspondent banks. As most global payment orders were initiated in cash, global payment providers managed their cashflow and deposits in bank accounts with fewer data transfers, which would delay the delivery of funds. Further, since the end of the Breton Wood Agreement in 1973, foreign exchange rates don't have a common reference asset. This means global payment providers face less clarity on foreign exchange rates and how these may change when there is limited data transfer and long waiting periods. In turn, margins tended to be higher and drove attention towards the development of straight-through processes, or more generally, the speed of global payment. In discussing such speed, data transferring and the availability of operating schedules by different global payment providers were central for effecting global payment.

> "Market settlement conventions, business practices and settlement procedures (eg cut-off times for submitting instructions) can directly influence the amount of time required to acquire and use backup liquidity sources" (BIS, 2008, p. 41; BIS2 Report).

> "Delivery versus payment mechanisms were also introduced over time, significantly reducing the principal counterparty risk that might otherwise arise from securities settlements" (BIS, 2008, p. 16; BIS2 Report).

Most recently, the discussion is around global instant payment, which is also taking place through cashflows, margins, and in particular, data transferring. As SWIFT illustrates, global instant payment as a future development takes place through effecting global payment, the managing of risks in global exchange through predictability allowing the transfer of funds to take place. SWIFT has been working on developing its new service, GPI, with the application of distributed ledger technology to facilitate data transferring. Such data transferring includes data on margins and allows for the rapid availability of funds as it also includes settlement and reconciliation data. As one executive in the industry imagines, such sharing of data and risk approaches implies that, in "ten years' time, volumes are going to be orders of magnitude of what they are today because people are paying small amounts more often… and part of that is everything will be real time. If you pay instantly, you can receive goods and services instantly" (INT19 Interview).

> "The challenges that the GPI community wanted us to try and address were, while moving closer towards that real time mode and the idea of operating in batches conveniently organized around old-fashioned concepts like the business day, could we use DLT to change things, to make things better, to eliminate some of that waiting time between when a problem is introduced onto an account and when we can identify it?..." (SWIFT Observation).

> "One of the things that GPI enables, in the domain of Nostro reconciliation, is the concept of unique end-to-end transaction referencing. This is important because [without such referencing] it becomes very difficult indeed to do the transaction-based reconciliation on the shared ledger. So, the idea that every correspondent banking transaction should be a GPI transaction, meaning it has a unique end-to-end transaction reference, is actually a prerequisite to successfully transition to sharing ledgers rather than sending them to each other" (SWIFT Observation).

In sum, effecting global payment means the managing of risks in global exchange so as to predictably allow the transfer of funds, and for changes in their speeds, to take place. However, for such instancy and global payment to take place, there needs to be physical accessibility. Ubiquitous causation, the infrastructural way for global payment to result from action, conveys

movement as effecting and as physically accessing the global transfer of funds, which also allows for their speed.

Accessing Global Payment

Global payment involves the presence of a wide audience. For global payment to take place, it needs to be physically accessible. For global payment to result from action, there are various ways of initiating and delivering it. Similarly, relations between existing global payment providers, which commonly culminate in what providers refer to as a payment network, allow for global payment to take place. And for global payment services to continue being global, it needs to extend to new areas. Following this background, payment channels, partnering, and network connections illustrate the physical accessibility of global payment, underlying how it takes place as a consequence acted for. In more detail,

- Payment channels are for initiating and delivering global payment.
- Partnering is forming relationships between global payment providers.
- Network connections are for extending prevailing global payment services.

> "Service channels and access points are the specific interfaces used to connect the payer/payee and the [global payment provider] so that a payment can be initiated or received. As with payment instruments, the capabilities and needs of end users generate variation in these interfaces across [global payment providers] and use cases. Service channels and access points further vary based on the payment instruments chosen by end users. For example, physical outlets such as branches, agents and ATM/kiosks still play a dominant role for [global payments] reflecting the continued use of cash at the initiating and receiving ends for that use case" (BIS, 2018a, p. 10; BIS52 Report).

There are different payment channels for initiating and delivering global payment. QRS, for instance, offers the options of initiating a payment through card terminals, cash, and through internet channels, e.g., a website. Similarly, QRS's partners in different countries offer various payment channels for people to physically access funds. For example, while some people need bank account services, others would use primarily cash services. In some cases, some QRS partners also offer payments through checks and bills, and even as home delivery cash services,

as is typical for the Dominican Republic. In turn, global payment results by payment channels, which global payment providers constantly diversify following the challenges people encounter for physically accessing global payment services.

> "in developing countries the banking network or other potential networks of agents may not be very extensive, especially in rural areas, creating a serious physical access problem for many receivers. Even where agents do exist, the domestic payment system needed to transfer the funds to the disbursing agents may be slow and unreliable or may lack adequate geographical coverage" (BIS, 2007, p. 14; BIS1 Report).

In addition to payment channels, partnering as the formation of relationships among global payment providers drives physical accessibility for global payment to take place, to result from action. Partnering involves referrals between different providers. At QRS, for example, the company's CEO has worked at different global payment organisations developing their network and managing relationships with existing partners. This relationships facilitate the formation of QRS service for global payment. The provider's partnering involves negotiations with the provision of projected transfers and income, and special requests by partners in different countries. For example, for servicing Nigeria, QRS conducted cash payments in Great British Pounds to settle with its partners by paying a local provider in the United Kingdom. In other words, rather than using banks and SWIFT, cash is paid in the United Kingdom to a partner in exchange for Nigeria Naira at QRS bank account in Nigeria, which is used to pay receiving clients at their bank account.

> "Many services require [global payment providers] to cooperate to create a network of access points and it may not always be easy for potential [providers] to identify suitable partners to do this, particularly in other countries. Moreover, underdevelopment of the domestic financial infrastructure, particularly in receiving countries, may mean that transferring funds to the access points is slow and unreliable; in some cases non-cash payment services may only be available in urban locations" (BIS, 2007, p. 3; BIS1 Report).

Moreover, network connections also allow for global payment to take place globally. These network connections are the accessing of, for example, a bank account, which allows global payment providers to settle global payment orders. When such connection was lost due to the

closure of its account, QRS partnered with a payment "aggregator," which handles the transfer of funds for other providers. Further, QRS had to partner with the post office to handle cash and to access a bank account. With the use of the post office, cash is picked up and deposited at the payment aggregator's account. With access to banking services and SWIFT, this aggregator deposits QRS funds at its account in Easter Europe. From this account, QRS does foreign exchange and settlement payments to its partners.

> "the cost and speed of [global payment] can be caused by the lack of standardisation for particular types of payment instruments and lack of interoperability between systems or arrangements, which means that their potential geographical coverage is not fully realised" (BIS, 2007, p. 15; BIS1 Report).

For global payment to take place, there is physical far-reaching access. Payment channels, partnering, and network connections illustrate such access, which also shapes the speed of global payment and extends beyond present structures. Straight-through processing, for instance, is long discussed across the global payment industry for improving global payment service accessibility following the rationale of reduced costs and further speed. Discussions around straight-through processing illustrate payment channels reaching unreachable geographical areas, partnering among different organisations, and network connections for speed in global payment. Since the establishment of |SWIFT back in 1973 speed and volume of global payment orders across the banking industry has taken place by channels, partnering, and network connections.

> "As an industry cooperative, SWIFT's primary goal was to serve its members in 'the best possible way':
>
> > [Our] objectives should be defined in function of the service we wish to offer to our member banks. [The first objective of SWIFT could be stated as] to offer member banks access to the largest number of national and international financial systems and networks through one interface.
>
> To understand this objective we need to remind ourselves of the original concept of SWIFT as a message carrier. Unlike other EFTs like CHIPS or BACS, SWIFT is only a channel for the transmission of financial messages" (Scott & Zachariadis, 2012, p. 471; SW2 Research).

> "Straight-through processing: the automated end-to-end processing of trades/payment transfers — including, where relevant, the automated completion of confirmation, matching, generation, clearing and settlement of orders" (ECB, 2009, p.25; CBEU1 Report).

Most recently, however, the work for global instant payment at SWIFT continues to take place with payment channels, partnering, and network connections. There is a consistent application of the standard ISO20022 across banks as well as central banks, which comes with the need to extend existing networks. Banks also need to access SWIFT GPI service for instancy and partner with banks using such service. Along the same lines, global payment executives imagine "the interoperability issue" being solved and having a global exchange "without borders" (INT2 Interview).

> "The central banks and market infrastructures are all (…) exposing how high-value payments as an entire end-to-end business process work, down to the definitions and contents of each individual field. This is quite interesting. So, the central banks are actually laying down the foundations for not only harmonization but interoperability. I think it is early days to see whether [the further interoperability of global payment services] is actually going to manifest itself yet. But the central banks have decided they're going to use the same [payment] meanings, the same terms, the same templates" (SWIFT Observation).

To summarise, managing margins, cashflow, and data transferring allow for global payment by managing the risks in global exchange and enhancing the predictability that a transfer of funds to take place. Payment channels and partnering and network connections allow for the physical access of global exchange, which results in the global transfer of funds. As emerging old discussions for the instancy of global payment illustrate, movement as effecting and accessing global payment implies action for payment predictably being present in many places.

Like a theatre performance, ubiquitous causation is the infrastructural way for global payment exchange to result from action, as a consequence acted for. There is movement preceding and proceeding action, for example, by risk approaches and the physical accessibility of global payment services, without which global payment wouldn't take place.

Conclusions on Global Payment Infrastructure Development

This chapter presents three infrastructural ways for global payment 1) to be objects, 2) to pass as real, as a valid past event, and 3) to result from action as a consequence acted for. *Granular Homogenisation* is the infrastructural way that exchange objects, for instance, payment orders and programmable tokens, come to be and change. This infrastructural way conveys movement as differentiating multiple payments and linking these to form global payment objects. Such objects are like pictures that hold realities that relate to others, making them durable.

Similarly, *Irreversible Validation* is the infrastructural way that global payment is realised as a valid past event, passing as real. As noted, an example here is when funds become available on the payee side and cannot be changed or reversed. This infrastructural way conveys movement as authenticating and completing global payment, forming past events. Such formation is akin to how lenses aid in seeing and reflecting an otherwise changing reality. Finally, *Ubiquitous Causation* is the infrastructural way for global payment to result from action as a consequence acted for. For instance, global payment takes place with risk approaches and physical presence. Here movement comes by effecting and accessing global payment, and global payment results as a consequence. Such a consequence takes place like a theatre performance, with acts and the inclusion of an audience.

These infrastructural ways underlie global exchange, but they do not belong to one global payment transaction. Instead, infrastructural ways cross providers and industries that exist because of global exchange. For example, global payment providers such as QRS exist with global exchange objects that emerged and linked to global banking payments as the remittance industry formed. A granular homogenisation way underlies such global exchange objects and their change, as documented with emerging programmable tokens. In other words, these infrastructural ways convey persistence and change. However, these infrastructural ways, which Table 9 summarises and illustrates, do not stand alone, or in isolation. As the next chapter details, infrastructural ways along these three infrastructural ways provide further evidence of the global payment infrastructure development without falling into a linear pattern or pathway, which would disregard movement in infrastructure development.

Table 9. Global Payment Infrastructural Ways			
Way	**Description**	**Movement as**	**Illustration of Structure**
Granular Homogenisation	The way for global payment to be objects for global exchange	Differentiating and linking global payment	Payment order
Irreversible Validation	The way for global payment to pass as real as a realisation for global exchange	Authenticating and completing global payment	Payment finality
Ubiquitous Causation	The way for global payment to result from action as a consequence for global exchange	Effecting and accessing global payment	Payment margin

CHAPTER SIX

Global Payment Infrastructure Development Part II

There is no infrastructural way standing on its own. Infrastructural ways are and develop along each other. There is movement. This chapter introduces three infrastructural ways to reveal such movement along the ones already described. Hurtling is the infrastructural way for global payment to be objects passing as real, which underlies the creation of global payment data. This new data takes place in a hurtling way, which conveys a straight-line movement along granular homogenisation and irreversible validation. Swaying is the infrastructural way for global payment to pass as real with action, which underlies new illicit global payment transfers. Such illicit transfer of funds takes place in a swaying way, which conveys a back-and-forth movement along irreversible validation and ubiquitous causation. Finally, rippling is the infrastructural way for global payment to result from active objects, which underlies new payment locations. Such new payment locations take place in a rippling way, which conveys a sequential waving movement along ubiquitous causation and granular homogenisation. An elaboration of these narratives and their movement continues below, and a summary closes the chapter.

Hurtling Along Granular Homogenisation and Irreversible Validation

The way for global payment to be objects is with the way global payment passes as real. Hurtling is such infrastructural way along granular homogenisation and irreversible validation. A hurtling way underlies the creation of global payment data, which broadly is an object passing as real for global exchange.

At QRS, for example, global payment orders take place together with funds becoming available on the payee side and not being changed or reversed. Following QRS' authorisation as a payment institution, its bank used to monitor the provider's know-your-customer compliance practices. Among these compliance practices is the identification of people and transactions, which its bank would review through regular visits for their compliance proposes before closing QRS account. QRS also reports to its regulator in the United Kingdom annually on its compliance procedures to keep its license, which implies a review of measures needed for authenticating the creation of global payment. With similarity, QRS followed its partners' compliance requirements in pay-out countries for assessing what is needed when creating a payment order. Lastly, agreements for completing global payment and reaching finality are reinforced by monthly negotiations with its partners and regulations for safeguarding funds in sending countries.

Further, the creation of global payment orders at QRS takes place with different messaging formats for different partners depending on the compliance regulations of the countries where the organisation is sending funds. For Spain, the .txt communication file must include the identification number of the person receiving the funds. Further, QRS partners use messaging to update the status of payment orders, which means the payment reaches some finality between QRS and its partner. The settlement, however, still takes place through banks and SWIFT giving further assurance to the completion of global payment, which is once again reviewed through changes in global payment orders following monthly negotiations and accounts reconciliations between partners. In this sense, global payment becomes objects passing as real, as global payment data, in a hurtling way that gives a straight continuum along granular homogenisation and irreversible validation.

During SWIFT's early days, for instance, discussions for the prevention of money laundering implied the creation of data. New data fields were established in SWIFT's messaging standard after negotiations between the cooperative's management and government organisations.

The creation of data came as a new field in SWIFT MT messages which became compulsory for the creation of global payment orders. This meant a hurtling way for global payment objects passing as real with new fields and changes in banks' practices forming for authenticating global payment.

> "The FATF were interested in SWIFT because a large volume of worldwide cross-border financial transactions pass through SWIFT and they wanted to explore the possibility of using that financial data (SWIFT messages) to trace illegal activities" (Scott & Zachariadis, 2013, p.128; SW1 Report).

> "SWIFT nonetheless decided that it was appropriate to address broader concerns regarding the SWIFT message template, which at this time did not have a specific field to include originator's data. This field was subsequently included and made mandatory in the message standard, which means that its omission will cause the SWIFT system to reject the message" (Scott & Zachariadis, 2013, p.128; SW1 Report).

This hurtling way and its movement for the creation of global payment data goes beyond SWIFT and banks. Around the 1990s, data quality was and continues to be very important for providers offering low-value global payment services. In their early days, however, global payment providers relied heavily on paper to create data, and compliance was conducted out of the need to mitigate fraud while maintaining relationships. The creation of global payment data followed the authentication of transactions following legible handwriting on the receiving country. Payment providers had a typist department for consolidating orders into a computer system, which meant legibility and procedures for it were in placed when creating global payment orders. Similarly, completing global payment implied paper-based identifications, e.g., signatures, which created global payment data.

> "Via fax. So, the branch was receiving a piece of paper with several instructions. And now that we are talking about it, I remember it very well. It was so manual that you had to tear the paper to organize every instruction.

> Then, for example, you came and OK, you are Juan Camilo… Give me your your ID, you are expecting money from whom? Ah from your auntie. Write how much, 100 dollars.

So that's how you had to sign and produce an identity document" (INT9 Interview).

During the 1990s these data were recorded manually, shared between organisations with the use of Fax, and funds transfers were in cash. For regulators and banks, these different transfers were a single global payment transaction between two providers in different countries. From a regulatory perspective and banks' perspectives, low-value global payments did not "exist." However, following the quest for reducing money laundering and the United States terrorist attack on 9/11 in 2001, closer monitoring translated into recognising global payment providers and their payments with the creation of global payment data for low-value global payment. Regulators, banks, and global payment providers came closer and began linking different payments and authenticating the creation of global payment, which came to underlie the creation of global payment data as objects passing as real.

> "It started; I'm telling you, compliance was basically the rules drafted by our company because that company was the founder of money transferring in [country name].
>
> The foundation of the rules was done in that company. So the relationship with the regulator and [the company] was very close. In that sense the regulator started learning about what money transfer was about.
>
> This industry was, in the past, invisible for the financial system. It grabbed the attention of the banks, later. I believe after 1994, maybe around the year 2000 it was that the banks started paying attention to this industry… it all came from the United States" (INT9 Interview).

Most recently, the infrastructural way of hurtling and the movement it conveys for global payment data creation is documented with programmable tokens forming with different relating payments, which takes place with how global payment is realised as a valid past event. Aryze's "programmable money" and "token," for example, requires a licence. In a hurtling way Aryze's token is developing by linking different payments and issuing a license that will allow the organisation to operate under a defined supervision framework through an e-money license and then a bank license.

> "Since we raised the first amount of money, I think that was back in 2019 or so, we have always had had it as part of our plan to get our own bank license.
>
> We have for the longest time anticipated that in the future the issuers of stable coins will have to be regulated financial institutions. Later we saw something called the US Stable Coin Act, which is just a proposal of a crystallization of what we at Aryze had already discussed. That banks need to be the ones issuing stable coins in the future" (Aryze Interview).

Similarly, at MakerDAO, a hurtling way underlies the creation of global payment data. MakerDAO's stablecoin, DAI, is paired with the United States Dollar, and such paring is with reserves created in Ether, a different cryptocurrency. DAI's tranfers follow the preestablished criteria in smart contracts based on Ethereum's shared "ledger." These contracts define the rules for buying and selling Ether following slight differences in price from the United States Dollars and are validated at Ethereum's Blockchain. For DAI to change, MakerDAO uses a "governance token," which is held by its governing community and now by different committees looking after the organisation's protocol. Updates in the protocol rules take place through votes by the different participants recognised by the MakerDAO community and the encoded rules for approving or rejecting a subsequent version DAI.

There is a hurtling infrastructural way underlying the creation of new data, an object such as DAI passing as real, which extends to future developments. For example, MakerDAO's DAI is developing with further links to "real world assets." MakerDAO aims to link with other payments to diversify its reserve and how its reserves are maintained. Such a change comes by MakerDAO's stablecoin developing with legally recognised payments and assets. Among these are the addition of corporate bonds to its reserves and the codification of further rules in its protocol for smart contracts. The links to different assets are also taking place with affiliated organisations assuring the completion of payment for DAI's data creation.

> "There really is a clear desire for [MakerDAO] to scale and become much larger. And that again means you need more collateral than the pure crypto collateral. This means we also need to get more real-world assets as collateral. And that has been moving slow because there is the legal, the regulatory things. But then there also is this thing when you can't

just get the asset and lock it up in a smart contract. There's a lot of more work around making sure that, in the case you need to confiscate the asset because you have a liquidation, the protocol can get it. Because again the protocol doesn't have, unlike many of the other protocols, a legal entity closely associated with it.

The Maker foundation dissolved. There is no legal entity, so there must be from case to case specific legal structures set up. Like trust funds that can assure, in case the collateral can't cover the outstanding debt, that we then have an ability to auction or liquidate the collateral. And there are exciting examples of real-world assets. One of the one of them was just published a couple of weeks ago, which is financing Tesla repair centres" (MarkerDAO Interview).

In brief, the way for global payment to be objects is with the way global payment passes as real. Hurtling is the infrastructural way for global payment to be objects passing as real, along granular homogenisation and irreversible validation. This infrastructural way conveys movement as a straight continuum for global payment data creation. As when a picture is made with a lens, there is a clear direction with objects and realisations underlying new payment data.

Swaying Along Irreversible Validation and Ubiquitous Causation

There is more movement than a straight continuum. The way global payment passes as real also is with the way for global payment to result from action. Swaying is the infrastructural way along irreversible validation and ubiquitous causation. Swaying and the movement it conveys is how global payment passes as real with action. This way underlies the creation of illicit payment, which, broadly defined, is the transfer of funds outside established regulatory frameworks — and transfers these frameworks do not account for.

For instance, QRS different know-your-customer requirements for authenticating global payment are based on the amount of funds to be sent. When the amount of funds crosses thresholds, global payment results with stricter regulatory requirements and planning, as a back and forth. There are meetings for data transferring to understand where funds come from, which include an investigation into the job of the person sending funds and a physical copy of bank statements. When funds are of high value for QRS, e.g., more than half a million dollars, calls

take place to inform QRS bank about the upcoming transfer. There is data transferring to coordinate the transfer of funds and make sure it is approved in the receiving country, which keeps cashflows stable as the completion of the transfer is planned to prevent delays. This swaying movement, back and forth, gives rise to illicit payments as some documents are altered manually by cashiers. For example, by completing a compliance form on behalf of clients, suggesting responses, and reworking documents rejected by partners, sometimes without customers' awareness.

Moreover, by having different forms of global payment licenses, there is authentication of global payment providers for the creation of global payment. However, some providers lack access to such licenses for different reasons. For instance, these licenses can be expensive to issue, or their global payment orders are not recorded as demanded by the regulator. In these cases, providers continue creating global payment orders with different licenses or partnering with other licensed global payment providers, and sometimes with illicit payments. In those cases, providers and clients would use other channels such as physical cash and money laundering structuring approaches where different senders people send money on behalf of others for illicit and non illicit activities.

> "On the one hand, an important corollary of encouraging competition to reduce prices and improve accessibility is that barriers to entering the [global payment] market should be reduced as far as possible, and regulation can be a significant barrier because of the costs of compliance. By itself, this would suggest keeping regulation to a minimum. On the other hand, other public policy objectives, such as the need to prevent money laundering and terrorist financing, may make some form of regulation essential" (BIS, 2007, p. 3; BIS1 Report).

Viewed differently, along irreversible validation and ubiquitous causation is a swaying way for global payment to pass as real with action, not only with regulation and not only with action. Such swaying way, which is along, underlies the creation of illicit payment. Since the early 2000s and after 2008, regulation of global payment providers has been a corollary of aims for controlling money laundering and terrorism financing. In other to manage risk, regulators developed a "high risk" list where global payment providers were included together with drugs dealing, gambling, arms dealing, and other high risk organisations. This listing was, arguably, initiated in the United States and extended to other countries. Following higher regulatory

oversight banks' reduced their exposure to risk, which translated in the closure of bank accounts for non-bank global payment providers. These latter providers refer to such regulation and its consequences as "de-risking," to convey banks and regulators low-risk decisions, and the closure of their bank accounts following banks and regulators' lack of oversight of their low-value global payment.

> "I think it must have been 2013. So, I went and asked [a group of regulators], has anyone heard about operation choke point? And they were like, 'what are you coming up with now darling? Do you know what choke means? You probably misunderstood that. Where is that coming from?
>
> You know, when people go to the bar after these meetings, you know, it is different.
>
> So, I was like, I was told that the Barack Obama government administration, I think it was 2011, created Operation Choke Point. And Operation Choke Point was about a list of industries that was sent to the banks and said do not bank this industry. They are high risk. And among those industries, you had marihuana dealers, you had arms sellers, you had gamblers, you had money transfer.
>
> People were like no, that doesn't exist. How can you prove it? Don't even dare to talk about that in one of the formal meetings" (INT2 Interview).

However, the closure of bank accounts took time and is still an ongoing debate. In other words, there is swaying way, preceding and proceeding the closure of bank accounts for global payment providers, for global payment to pass as real with action. As some of the large global payment providers are still profitable for banks and manage large funds across multiple banks, these organisations were less affected. Thus, the affected global payment providers partnered with other global payment providers and became agents. Some global payment providers, however, sued banks for their right to have access to operate, while others began issuing different regulatory licenses, such as a banking licence.

"All the global payment providers were losing their bank accounts.The first ones were the medium size organizations.Then the top five were affected. It was happening everywhere. You know in the caribbean, everywhere.

Juan Camilo: Did money keep moving?

Yes, so what they did. For example [name of a bank], when it closed the bank account [to a global payment provider], this provider won a court case and the bank had to open their account again. But it opened it only for one year. That was the agreement and they did an agreement for that. They opened the account for one year until the [global payment provider] finds another bank account. Of course, no bank wanted to bank them. Banks were saying no. What if they take us to court as well? No.

That's why the [work we did with the regulators] was very important. Because we were supposed to support these organizations, I mean it was a big thing. A lot of other little operators continue taking their banks to court. But it was very difficult" (INT2 Interview).

At the same time, regulators continue working and supporting global payment providers. Working groups with different regulatory agencies implied that banks were also subject to follow regulatory procedures. Some global payment providers began moving countries to find a bank account in different parts of Europe or outside, while offering their services in these countries through partnerships with other payment providers. For example, in the United Kingdom, some of these organisations began partnering with the post office, which would pick up cash and transfer funds on behalf of global payment providers to different countries.

"Suddenly we had, for example, with the [regulator] blessing, cash flying to the Middle East. Export of cash.

Juan Camilo: Cash flying? When was this?

It's still happening now. Yeah, you talk about blockchain and cryptocurrency, and then you have cash flying" (INT2 Interview).

However, having a different license, suing a bank, or partnering with other organisations is not always possible. Those circumstances don't mean global payment stops, with no access to banking services. This swaying way underlies the creation of illicit payment for global payment providers to continue operating or reduce some of their regulatory costs. Most commonly, it would take place by using cash as the primary means of payment and moving it across countries, sometimes until it reaches the receiving country. In this way, global payment services continue to take place with accessibility to different payment channels and, sometimes, legal. While there are costs associated with flying cash, such costs also come to be accessible when compared with other costs that these providers may have to incur with the opening of a bank account.

> "It was very expensive to find an alternative solution, but in some cases and at some point it was cheaper to fly money than to have a bank account.
>
> Juan Camilo: In which way?
>
> Well, first of all, if you go to the bank with cash, it's so expensive to count cash. When I managed [a global payment provider], I was paying something about £20,000 or £25,000, plus X amount for them to count. So, you pay for counting, then you had to pay for whatever company you have as cash carrier that comes pick it up, and security too. So it was so expensive to take cash to the bank, you have to go with two or three employees. You know, you have to be careful. So suddenly yes, it was cheaper to fly money than to [have a bank account and pay electronically]" (INT2 Interview).

Considering the issues of accessibility, partly for global payment providers, new regulations are taking place for authenticating and accessing global payment. While not intended to global payment providers, Europe's payment service directive two facilitates access to third parties' bank accounts, allowing predictable and far-reaching global payment services. The oversight and subsequent transactional service supported with Blockchain systems also gives alternative funds transferring channels for global payment providers with no licenses or access to bank accounts. At the same time, however, new regulations such as Europe's Markets in Crypto-Currency Assets (MiCA) imply oversight and restrictions to global payment providers supporting stable tokens, which underpins the closure of some of these services and the authorisation of

others. In this sense, the infrastructural way of swaying, along irreversible validation and ubiquitous causation, is underling the creating of new illicit payments and their governance.

> "Now, we are navigating the the ecosystem and the requirements all the time and continuously adapting and changing. But I think that one thing which remains is that we wanna end up with having a bank license. Because having a bank license essentially means that you as a bank have a direct deposit address or direct bank account with the central banks" (Aryze Interview).

Similarly, at SWIFT the instancy of payment services is not only taking place with predictability through data transferring and with participating banks including such messaging in their services. There also are oversight and rules for completing global payment transfers on time in its new GPI service. Participating banks need, as a requirement, to share data and confirm the reception of payment messages and the crediting of funds to participate in the messaging network's new service. In addition, banks are working on reviewing their data transferring and cashflow management because the new required confirmation of payment comes with implications, a back and forth, for how banks profit from foreign exchange and handle large payments.

> "GPI is not only a solution but a framework whereby banks need to confirm the posting to the beneficiary within 24 hours. [This] means that today we've seen a drastic improvement in customer experience. We've seen that 40% of cross-border payments on the SWIFT Network are confirmed within five minutes" (SWIFT Observation).

At MakerDAO, changes in the algorithm take place with a back and forth. For instance, during March 2020 when there was a drop in the value of cryptocurrencies such as Ethereum's Ether, the stability of DAI came into question. This back and forth led to the inclusion of other crytocurrency assets relying on an authorised organisation and banks for its stability. The ideological aim of "creating a central bank in the blockchain" as the organisation describes itself came into question (MakerDAO Interview). At the same time, MakerDAO's governance token holders took the decision of adding this new asset to its reserve to back the value and stability of DAI as it was the only way of having additional cashflow. The votes were electronically verified using cryptographic keys, which then led to the needed changes in the algorithm.

> "we all remember the events of Black Thursday where crypto markets dropped by 50% in a single day. The then 4-month-old Maker protocol came very close to collapsing due to unprecedented stress as well as an oversight in how the auction system worked. But we prevailed, barely…. As an emergency response Maker holders elected to onboard USDC to wrangle the peg back in line, and it worked! But there was an ideological cost. It was our first custodial, blacklistable, centralized asset" (MakerDAO Documentation).

> "current DLT implementations for payment, clearing and settlement activities are focused on restricted arrangements, which more closely fit within existing legal and regulatory frameworks. Assigning particular roles to a broad range of entities and their nodes may introduce other important issues. For example, if only certain nodes are delegated to achieve consensus, it may be easier (and faster) to reach consensus on the state of the ledger; however, it may also be easier for any one of these nodes to compromise the integrity of the ledger. Thus, it is important that such an entity is known and trusted by participants" (BIS, 2017, p. 9; BIS107 Report).

More generally, swaying is the infrastructural way for global payment to pass as real with action, along irreversible validation and ubiquitous causation. The back-and-forth movement of this infrastructural way underlies the creation of illicit payments. Just as lenses help in seeing and reflecting a real-life performance, but cannot help to see everything on stage at once, there is a back and forth with realisations and actions underlying illicit payment.

Rippling Along Ubiquitous Causation and Granular Homogenisation

Lastly, the way global payment results from action is with the way for global payment to be objects. Rippling is the infrastructural way along ubiquitous causation and granular homogenisation. This infrastructural way, and the movement it conveys, is for global payment to result from active objects, which underlies the creation of new payment locations.

Multiple global payments and their location follow cashflows and working capital needed for predictability and the management of risk. At QRS, the average amount of global payment transfers at this provider is 300 United States Dollars, which is an amount not addressed effectively with global payment services at banks. The case is similar for global payment transfers of high amounts, where global banking services would effectively charge a fixed fee of about twenty United States Dollars and a difference in the exchange rate. These two different payments draw different locations, which are place, funds, and time it takes for a transfer. In other words, there is a demarcation with global payment objects and the predictability of cashflows that comes together with different payments.

Even though it is difficult for QRS to know when its settlement payments to its partners in a different country are to be received in their bank account, global payment to people still takes place with certainty. Global payment orders continue to be cleared and subsequently are paid out to people by QRS partners. When it is necessary, QRS sends its partner proof of the settlement payment (e.g., a copy of QRS' bank MT103 SWIFT message) to increase its credit limits and continue servicing people. Thus, global payment results by active objects in a rippling way, a sequential waving, underlying payment locations.

> "to the extent that there is some uncertainty about the time (eg because of uncertainty about how fast banks will process payment instructions), the payment providers can still offer a fixed transaction time provided that information flows separately from settlement and that the speed of the information flow is known (eg instantaneous if a computer link is used): the [global payment provider] can then agree with the disbursing agent that payment to the receiver will be made when the information is received or at a fixed time afterwards and, if necessary, that liquidity will be made available to the agent to enable this to happen" (BIS, 2007, p. 12; BIS1 Report).

During the 1980s, for instance, messaging came with implications for global payment to take place at global payment providers. The careful writing and encoding of global payment orders meant global payment would take place. Organisations would spend time and resources on the clarity of handwritten messages and for their transfer into computing systems. Having issues with the legibility of global payment messages meant subsequent payments were not completed as these wouldn't reach payees.

> "I want to stress to you what I mentioned before, the quality [of data]. Because it was so manual. It meant obtaining [this data] was very important. For example, if the person writing down the instructions wrote the number seven or the number four, and it was not legible, it was an issue. At the destination part, we couldn't contact the person" (INT9 Interview).

This means global payment takes place with different active objects for correspondent banking, global payment providers, and local payment in a country — all of which have different forms of predictability and accessibility and include different forms of action for the creation of payment locations. For illustrating such rippling way and the movement is conveys, it serves to review QRS' foreign exchange payments. Following cashflows from its investors and computing integrations with multiple partners allows global payment to take place at QRS. When a transfer is initiated, QRS also does foreign exchanges at its bank in eastern Europe following the closure of its account in the United Kingdom. An email request for the foreign exchange means an instant conversation between currencies as there is no "outside" payment and all happens within the same bank.

> "So you have to distinguish. Remember foreign exchange is not regulated. Payments are regulated. So, you can trade all the foreign exchange you want, and you're not a regulated company. But if you pay one dollar from the UK to France, that's a regulated activity. So, the actual conversion is instant. Foreign exchange markets work instantly" (INT13 Interview).

Despite an instant conversion, the foreign exchange bank or dealer still needs to manage further payments and exchanges. With a large cashflow and volume of funds, such exchange may occur at the CLS bank. CLS bank has accounts with different central banks and offers a payment versus payment model, meaning that exchange and delivery of funds take place as soon as the funds are received at the bank. Nonetheless, when the conversions are not large enough, different providers offer middle-range services. In these cases, foreign exchange providers integrate with global payment providers, most recently with APIs, which facilitate connectivity across global payment services. In this latter case, the foreign exchange providers centre on managing multiple accounts across different countries, dealing with various forms of settlement at their banks, and

paying providers as soon as the funds are requested, which recently takes place on an order per order basis.

> "One of the things about sending money is the world is often based on a correspondent banking basis. And there's very few banks that have everything. So, for example, when [Bank name] sends to India, they may send it directly, but if they send it to Malaysia, they may send it to another bank. So even with a large bank that has a large distribution network, say [Bank name] or [Bank name], which have the largest networks. They won't necessarily have a bank everywhere, so there's a huge amount of delays in the process of sending money.
>
> You don't see that in Europe, because in Europe we have relatively instant euro, relatively instant pounds, in the US is much slower, but within Europe, pounds and euro are instant. In the rest of the world is not so instant" (INT13 Interview).

Along ubiquitous causation and granular homogenisation, this rippling infrastructural way for global payment to result from active objects underlies payment locations and their change and creation. For example, Aryze global payment token is based on the purchase of different government bonds in different currencies after investors deposit funds at the provider. This set up allows Aryze to pay back interest rates and to offer different global payment services. Aryze programmable token is with the predictability and accessibility that comes with various bank accounts, cashflow, and data transfers from multiple payment providers. Such different active objects broaden the location for global payment, as it becomes possible to "use funds instantly…without money ever having to move. Not only [it does not] have to be moved, but it also doesn't have to be liquidated from the bond in which it is placed" (Aryze Observation).

> "We see that, of course, we would need a corresponding bank that has a banking license and can process foreign exchange. So, we see it as—depending on which region or currency we are in, we would have to have a corresponding bank that can handle in that currency" (Aryze Interview).

> "It is becoming harder and harder to offer a service that is only money transfer. Because increasingly that is becoming, the pricing is being driven so low, to 0, especially with

companies that can offer something else on the side. I mean different products like an actual virtual account for money storage and interest rates" (INT18 Interview).

Similarly, SWIFT GPI service follows the transfer of data and management of cashflows affiliated banks need to do. The new service striving of instant delivery of funds entails linkages among different payments with the standardisation of data, and, recently, a transition to the new global payment standard ISO20022. This means that on a transaction per transaction basis, all details of its costs and the definition of a settlement amount become inherent in the global payment transaction, which also facilitates other services and new payment locations.

"One of the things that GPI enables, in the domain of Nostro reconciliation, is the concept of unique end-to-end transaction referencing. This is important because [without such referencing] it becomes very difficult indeed to do the transaction-based reconciliation on the shared ledger. So, the idea that every correspondent banking transaction should be a GPI transaction, meaning it has a unique end-to-end transaction reference, is actually a prerequisite to successfully transition to sharing ledgers rather than sending them to each other" (SWIFT Observation).

As last evidence is the creation of global payment locations in developing countries. In these regions, cash is still the primary payment channel and method for paying out global payment orders. Since the early 2000s, the first online global payment provider in Europe began by partnering with mobile payment service providers in some of these regions and primarily in Africa and Asia. Following different technical integrations with telecommunication providers drew the creation of new payment locations for people in these regions. Telecommunication providers began participating in global and local payment services since the early 2000s. The result are multiple active payment objects for people receiving funds not only in their local kiosks and grocery stores. Sending these funds can also take place in a new location, such as cargo ships in international waters where a community of Philippine citizens work.

"Prior to this [mobile payment service], people would send cash on a bus. Let's say if you're the young man who has gone to the city to work. You would be sending money back to your mum in a village, or your wife. Maybe once every couple of weeks. And either is you finding the opportunity, like 'when can I go back and spend a couple of days

back in the village.' Or 'maybe I know a friend of a friend of a friend who is going to go back in two days time, I got to give him my pack of money' literally a sack of cash. 'give it to him, give him some money to make sure he gets it to them when he takes that bus back.' It's extremely dangerous and challenging in many ways. That is the very extreme example, but it is extremely common in many markets still [today]" (INT18 Interview).

"The success of [mobile payment services] was that the mum didn't have to go all the way to the [telecommunication] shop in the main town. She could go to the very local, literally, little kiosk. Like a guy on a corner with a wooden shack who was selling scratch cards for airtime [top up cards for mobile phone calls], but he would also give her the cash. So, she would send to him that virtual [money she had received], she puts in the agent number and sends the money virtually, and then she gets the money in cash" (INT18 Interview).

In summary, the way for global payment to result from action is with the way for global payment to be objects. Rippling is the infrastructural way for global payment to result from active objects, along ubiquitous causation and granular homogenisation. The sort of sequential waving movement that this infrastructural way conveys underlies the creation of new payment locations. Just like a series of acts come to change a theatre performance, there is a sequential waving with actions and objects.

Further Conclusions on Global Payment Infrastructure Development

The global payment infrastructure develops with movement along infrastructural ways. There is a reversal in what matters, which are the infrastructural ways and movement these convey rather than the structures that come and go along ways. Toward this end, this chapter presents hurtling as the infrastructural way for global payment to be objects passing as real. Hurtling is along and in movement with granular homogenisation and irreversible validation. Hurtling conveys a straight-line movement that underlies the creation of global payment data, which, in the case of the global payment infrastructure from 1973 to 2030, is an object passing as real for global exchange.

In addition, this chapter presents swaying as the infrastructural way for global payment to pass as real with action. Swaying is along irreversible validation and ubiquitous causation and conveys a back-and-forth movement. This infrastructural way underlies the creation of illicit global payment, which in the case of the global payment infrastructure from 1973 to 2030 is the transfer of funds outside what established regulatory frameworks account for. Lastly, the chapter presents rippling as the infrastructural way for global payment to result from active objects. Rippling is along ubiquitous causation and granular homogenisation and conveys a sequential waving movement. Rippling also underlies the creation of global payment location, which in this case is the place, funds, and time for global exchange. As Table 10 below summarises, global payment infrastructure develops with movement *along infrastructural ways*. These infrastructural ways not only offer a conceivable explanation for the unprecedented and temporally long global payment infrastructure development but also question the predominant assumptions on infrastructure development, which emphasise persistence and change. The following chapter discusses such implications.

Table 10. Ways Along Global Payment Infrastructural Ways

Way	Description	Movement Along	Illustration of Structure
Hurtling	The way for global payment to be objects passing as real	Granular homogenisation and irreversible validation	New global payment data
Swaying	The way for global payment to pass as real with action	Irreversible validation and ubiquitous causation	New illicit global payment
Rippling	The way for global payment to result from active objects	Ubiquitous causation and granular homogenisation	New global payment location

CHAPTER SEVEN

Infrastructure Development Along Ways

This thesis set out to answer how the global payment infrastructure develops. The results are the different ways the global payment infrastructure develops and an ontological approach for revealing movement. Along ways, as an ontological approach, revisits the isolation of infrastructure development based on tensions and the stasis that arises with them. Correspondingly, the study redresses the development of the global payment infrastructure with movement along ways, with important implications for regulators and global payment providers. This chapter unfolds these contributions in more detail. First, it offers a discussion clarifying along ways as an ontological approach for movement. Then, it revisits research streams on infrastructure development and positions the infrastructural ways already described, which differ from processual and relational findings. Finally, the chapter overviews practical implications before it concludes.

Along Ways as an Ontological Approach for Movement

Along ways foregrounds movement and gives an understanding in which movement is primary. The ontological approach goes from everything moves to movement is everything. What matters is movement rather than structure defined through the stasis that comes with ends, which a network metaphor implies. In other words, structure serves to find *infra*structural *ways* that are revealing, temporal, natural, and coexisting and help redress structure beyond ends. This intellectual ground gives temporality to unprecedented outcomes and change and dynamics to stable structures with movement.

To grasp the approach, it is worth clarifying how along ways is ontologically different from the prevailing research streams on infrastructure development that arguably extend to fields other than information systems and infrastructure studies. Two reference views on development by organisation and management scholars exemplify. The first one gives primacy to form over change. Following such an assumption, development becomes a sequence of changes in state or form over time. For example, Van de Ven and Poole (1995, p. 512) emphasise that "change, one type of event, is an empirical observation of difference in form, quality, or state over time in an organizational entity." Development, then, is "a change process (i.e., a progression of change events that unfold during the duration of an entity's existence-from the initiation or onset of the entity to its end or termination)."

The second reference view foregrounds change over form (Chia, 1999; Tsoukas & Chia, 2002). This assumption places change in situ and as immanent. Therefore, change is "anti-genealogical in the sense that it resists the linear retracing of a definite locatable originary point of initiation" (Chia, 1999, p. 222). The past and future lie within a constantly emerging present. The understanding of development lies with the understanding of change, which "must be approached from within" as a "performance enacted in time" (Tsoukas & Chia, 2002, p. 572). Attention comes to situated action and the application of ethnographic techniques, which by attending to "situated human agency unfolding in time, offer us insights into the actual emergence and accomplishment of change — They are accounts of change par excellence" (Tsoukas & Chia, 2002, p. 572). Acknowledging endurance of structure and outcome for structure is similar to these views, which Simmel's (1978, p. 515,516) tinkering below further unravels. The following passage comes from Simmel's magnum opus on the philosophy of money and from a section titled "Constancy and flux as categories for comprehending the world."

> "If we consider the substance of the world, then we easily end up in the idea of an unchangeable being that suggests, through the exclusion of any increase or decrease in things, the character of absolute constancy. If, on the other hand, we concentrate upon the formation of this substance, then constancy is completely transcended; one form is incessantly transformed into another and the world takes on the aspect of a perpetuum mobile.
>
> Whereas timeless objects are valid in the form of permanency, their opposites are valid in the form of transition, of non-permanency"

Along ways is different. Permanency and non-permanency give an end, defined through stasis. Instead, along ways conveys movement without nihilism and isolation. There is a historical and present conditioning serving to reveal movement beyond a situated discontinuous occasion. However, such historical conditioning is neither linear nor in a structure. Any immanence in situ or in wholeness is not without movement. For example, following a primary understanding that movement is everything, Bateson's (1972) immanence in wholeness is not still because nature is historical and temporal. There is a temporal existence with movement (Heidegger, 1977). Similarly, Heidegger's (1977) temporal continuum doesn't end with itself. Movement conveys causality in an ongoing way that is natural and along with others (Bateson, 1972). Thus, *it is along ways*.

With along ways, movement precedes and proceeds structure, which helps to rethink its ends. Along ways reveals movement by giving a temporal existence and natural coexistence to structure. Corollary to this background, the *way* in along ways not only follows Heidegger's Gestell and Gelassenheit understandings of Technology. In addition, way conveys all the meanings that are commonly attributed to the word in English. These meanings include manner, form, path, route, motion, method, style, state, and direction, among many others the reader may think of. While varied, all these words and meanings assume a temporal existence. The case with the word *along* is similar; it goes beyond Bateson's ecological understandings. While emphasising a natural coexistence, the word conveys being in company with others, extending horizontally, motion, and the passing of time, among others.

Accordingly, along ways contributes an ontological approach, a way of conceiving how something is (Heidegger, 1927), which reveals movement. Infrastructure is not a structure that changes nor the creation of structure, which in infrastructure studies follows the gerund infrastructuring. Instead, stasis and ends fade with temporal existence and natural coexistence of movement along infrastructural ways, which defer from processual and relational ontologies. As Heidegger warns, Heraclitus's phrase "going toward" should be handled with caution (Heidegger, 1966, p. 87-89).

Revisiting Infrastructure Development

In addition, this work addresses the isolation of infrastructure development in infrastructure studies. While the thesis sympathises with and stands on prior infrastructure studies that address tensions, the ends tensions convey are not always clear nor practical. Acknowledging the endurance of structure brings up tensions between structures and the *conditioning of past on present and future* infrastructure with *enduring structures staying still*. When there is an outcome for structure, tensions resolve following the *present conditioning* of multiple relationships, which bring up different structures in *discontinuous situated occasions*. Thus, there is an isolation of development, which is not necessarily useful because it brings a pragmatic end and way out of what otherwise is an unbounded infrastructural development.

For example, the endurance of structure often is based on critical realist assumptions (Bhaskar, 1975), which allow for chronology (Archer, 1995; Faulkner & Runde, 2019; Mutch, 2010). Even if mechanisms are dynamic in infrastructure development, there is a temporal difference that breaks past and present infrastructure (Giraldo-Mora et al., 2019). This separation allows for social and material structures to be apart before interactions, which drive tensions (Geels, 2002; Leonardi, 2011). As a result, there are periods of stability and, subsequently, periods of change. Infrastructure development, then, follows momentum, path dependency, and trajectory (Hanseth, 2000; Henfridsson & Bygstad, 2013; Hughes, 1987; Mayntz & Hughes, 1988). However, by emphasising persistence, there is a lack of change in infrastructure and a questionable stasis that makes new structures appear de novo.

Similarly, albeit differently, the way out for acknowledging an outcome for structure is based on relational and pragmatist grounds (Barad, 2003; Peirce, 1998). Much diversity comes with relationships between actors to define a single stable structure. Thus, infrastructure takes place when tensions resolve with an outcome in the present moment, which leads to the pragmatic and momentary demarcation of a form, a structure occasion (Bowker & Star, 1999; Orlikowski & Scott, 2019; Ribes & Finholt, 2009; Scott & Orlikowski, 2022; Venters et al., 2014). There needs to be an outcome for structure, otherwise there is nothingness. Therefore, there is infrastructuring (Aanestad et al., 2014; Reimers et al., 2022). However, by emphasising change, there is a lack of continuity and a questionable stasis by infrastructure occasions occurring in situ.

With closer attention to the global payment infrastructure, infrastructure development does not seem to stop with tensions and the ends these convey. Instead of appearing de novo, new

structures such as Bitcoin (Nakamoto, 2008) are with infrastructure already present, which also goes beyond Bitcoin itself and includes banks, payment cards, countries, currencies, and other far-reaching systems. Structures do not seem disconnected or delimited in chronology. On the contrary, there is much heterogeneity in and beyond any structure. Similarly, the global payment infrastructure is not in situ and is not developing with temporally bounded incidents. For example, global payment infrastructure continues beyond the closure of global payment providers' bank accounts. Global payment infrastructure in Somalia continues with global payment organisations informally flying cash to the country. Meanwhile, the closure of accounts also continues an ongoing discussion at the Wolfsberg Group,[31] which goes beyond a bounded occasion.

Accordingly, there is no isolation in infrastructure development with along ways. Instead, infrastructure development is with movement, which includes change as a difference in form but differs from it temporally. As there is movement in infrastructure development, such development is temporally long compared to a transition, yet far more dynamic to define an infrastructure staying still. Movement is temporally varied, and so is infrastructure development. Thus, there is no extraordinary change that is not part of an ongoing development. In light of this background, this study validates recurring findings on infrastructure development that bring up persistence and change. However, the infrastructural ways Table 11 summarises also revisit such findings and address the isolation of infrastructure development.

For example, *granular homogenisation, irreversible validation,* and *ubiquitous causation* bring up an infrastructure development akin to studies acknowledging the endurance of structure in infrastructure development (Ciborra & Associates, 2000). These infrastructural ways for global payment to be objects, pass as real, and result as a consequence acted for, resonate with the architectural, institutional, and functional emphases in infrastructure development. Granular homogenisation brings up movement as differentiating and linking global payments, which support existing findings on complexity in infrastructure development that present multiple connecting systems. As is the case with patient records, there is an ongoing infrastructural way for global payment objects, which one could relate to trajectories for growth and complexity (Braa et al., 2007; Hanseth et al., 2006; Henfridsson & Bygstad, 2013; Simon, 2002). However, by being grounded in global exchange, rather than separating the activity of global payment from its

[31] For reference, the Wolfsberg Group is an "association of thirteen global banks which aims to develop frameworks and guidance for the management of financial crime risks, particularly with respect to Know-your-customer, Anti-Money Laundering and Counter Terrorist Financing policies" (Wolfsberg Group, 2022).

structure, granular homogenisation brings up an ongoing movement addressing global payment objects such as orders and tokens. In other words, these global exchange objects form and come to exist by differentiating global payment and linking global payments, which explains past, present, and new structures not as sub-systems or new architectures. Instead, such structures are and change with the ongoing infrastructural way of granular homogenisation and the movement of differentiating and linking.

Such is also the case with the infrastructural ways of irreversible validation and ubiquitous causation. Irreversible validation conveys movement as authenticating and completing global payment, which resonates and supports findings outlining how rules for governing behaviour persist in infrastructure development (Bogusz & Morisse, 2018; Currie & Guah, 2007; Zorina & Dutton 2021). Movement as effecting and accessing global payment in ubiquitous causation also resonates with findings presenting the role of digital technologies in risk and financial infrastructures for the recreation of risk with novel payment instruments (Ciborra, 2006; Kallinikos, 2006b; Shiller, 2003). However, because irreversible validation and ubiquitous causation are with the activity of global payment and, more generally, global exchange, there are no tensions between logics nor sequencing based on a functional structure, both of which bring up stasis.

As movement is authenticating and completing in irreversible validation, the infrastructural way does global payment. This infrastructural way conveys how global payment passes as real as a realisation for global exchange. Such a way explains past, present, and future structures, such as traditional and emerging licenses for global payment providers and their practices for completing global payment. In a similar vein, ubiquitous causation conveys movement for global exchange as effecting and accessing global payment. This infrastructural way underlies how global payment takes place as a consequence acted for. Thus, present, past, and future risk structures such as margins and payment channels cannot be isolated because of movement as effecting and accessing underlies such structures. Accordingly, infrastructural ways depart from tensions and sequence in infrastructure development while maintaining a temporally long development and infrastructure.

Moreover, the infrastructural ways along, namely, *hurtling*, *swaying*, and *rippling* also bring up an infrastructure development akin to studies acknowledging an outcome for structure (Star & Ruhleder, 1996). For example, the straight-line movement hurtling brings up for the creation of new global payment data supports the creation of boundaries that takes place with an outcome, which excludes and includes (Star, 1990; Ribes & Polk 2014). The infrastructural way

of swaying and its back-and-forth movement underlying the creation of illicit global payment also supports shifts in infrastructure development trajectories (Oborn et al., 2019) and findings of regulatory changes in standards that contrasts digitalisation waves with opposing undertows (Scott & Orlikowski, 2021). Finally, albeit not closely, rippling and its waving movement for new global payment locations also supports inclusive outcomes in infrastructure development that are as local as they are global (Rolland & Monteiro, 2002; Vaast and Walsham, 2009; Venters et al., 2014).

However, these infrastructural ways also differ from the constant creation of infrastructure, which takes place with multiple infrastructural relations driving change. Instead of having infrastructure development in situ, the infrastructural ways of hurtling, swaying, and rippling and their movement are along other ways. This means the creation of new global payment data takes place in a hurtling way along granular homogenisation and irreversible validation. Albeit with change, there is a long infrastructural development along ways even though hurtling conveys a fast and in situ data creation. New payment data defined as an object passing as real takes place in a hurtling way along the infrastructural way for global payment to be object, e.g., order, and the infrastructural way for global payment to pass as real, e.g., regulatory practices for its completion, which have for long been present.

Moreover, there is not only a straight-line movement with hurtling; swaying is the infrastructural way underlying new illicit global payment, along irreversible validation and ubiquitous causation. This means that even though new payment data may involve new regulations, these do not necessarily stop global payments from taking place with an exclusion. Swaying conveys such back and forth movement along irreversible validation and ubiquitous causation for global payment to pass a real with action. Thus, with swaying, illicit payment does not occur in situ but with already present alternative payment channels that allow global payment to continue taking place and pass as valid.

Similarly, new global payment locations also follow a temporally long infrastructure development. The infrastructural way of rippling along ubiquitous causation and granular homogenisation underlies how global payment results by active objects. This infrastructural way underlies new global payment locations taking place along the way for global payment to be objects and the way for global payment to result as a consequence acted for. Thus, new global payment locations do not happen in situ. Instead, new locations form with a wave like movement that a rippling way conveys. Such movement explains that global payment objects carry action for the creation of a global payment location because of present infrastructural ways that are without stasis. Thus, such action is not in situ.

In sum, by revealing movement in infrastructure development, this work supports existing findings while addressing the isolation that comes with ends, which are only sometimes clear or helpful. Undoubtedly, as discussed in the chapter *Infrastructure Development*, there is much change acknowledging the endurance of structure and much history acknowledging an outcome for structure. For instance, recent studies on infrastructure development address processes for stabilising and destabilising structures before transitions take place (Hanseth & Modol, 2021), which gives change to an enduring structure from which sequence takes place (Leonardi, 2011). Historical processes preceding changing outcomes (Reimers et al., 2022; Scott & Orlikowski, 2022) also bring longevity to an otherwise situated infrastructure development.

Table 11. Key concepts in understanding movement

Way	Description
Granular Homogenisation	The way for global payment to be objects for global exchange
Irreversible Validation	The way for global payment to pass as real as a realisation for global exchange
Ubiquitous Causation	The way for global payment to result from action as a consequence for global exchange
Hurtling	The way for global payment to be objects passing as real
Swaying	The way for global payment to pass as real with action
Rippling	The way for global payment to result from active objects

However, in sequence, transition, and tensions, there is first a lack of movement that comes from ends, which are those abstract stable forms before conflict and breakdowns. Not only does such an emphasis on ends opaque infrastructure development with some form of transcendence, but they tend to overemphasise its persistence and change. Such emphases bring ethical questions to what is often called the digital transformation in global payment infrastructure (Gomber et al., 2018), which does not necessarily align with sustainability quests (United Nations, 1987, 2015). Because infrastructural ways convey movement, which is natural and without transcendence, they bring up continuity in an inclusive and non-conflicting manner while still accounting for change. Accordingly, infrastructural ways ethically complement prevailing views on infrastructure development, which, through tensions, recreate conflict and exclusions. Lastly, infrastructural

ways offer a way to clarify such tensions, transitions, and sequence with movement, which, while uncomfortable, can be useful and bring harmony for managing conflicting breakdowns.

Reinterpreting Breakdowns in the Global Payment Infrastructure

Practically, because movement helps understanding and creating non-linear continuities, it helps redressing the unprecedented development of the global payment infrastructure and the breakdowns such development implies. Accordingly, infrastructural ways help to understand the accumulation and change in the global payment infrastructure and take action. Recalling some of this thesis' practical motivations serves to unfold such practical contribution. As the first quote below illustrates, opposing past vis-à-vis new global payment infrastructure drives an argument of infrastructure development based on conflict and breakdowns (BIS, 2008, 2018a; Borio et al., 2020; Hartmann et al., 2017; Osterberg & Thomson, 1999; Shiller, 2003).

> "The task of interconnecting domestic payment infrastructures is a complex undertaking, and studies note the limited success of projects in this area to date and the challenges of implementing such arrangements. Closed-loop systems are, by contrast, easier to establish and are reportedly seeing the fastest growth of all back-end arrangements. There are two key risks associated with such growth: first, that a lack of supervisory oversight of closed-loop systems might fail to identify possible shortcomings in their risk management; and second, market inefficiencies in terms of (a) fragmentation if there is a proliferation of non-interoperable systems or (b) dominance if only a few prevail" (BIS, 2018a, p. 11).

What the infrastructural ways for global payment mean for practice is that there is no way to control the development of this infrastructure or to define it in a stable form or system. However, this does not mean the global payment infrastructure is discontinuous and there is nothing to do. *Even though we do not know what it will be, we may know the ways in which it will be by including others, reflecting, and imagining*. Table 12 provides a summary of such practical use of the infrastructural ways found in this study. The column "So what" works as a diagnosis exercise for the reader.

However, before proceeding, some words of caution are worth bearing in mind. For readers looking for a magical point or condition whereby infrastructural ways and their movement

activate, there is none. The development of the global payment infrastructure doesn't work that way. As the wise executives that contributed to this study would outline with their metaphors and imagined scenarios, this infrastructure is difficult to grasp. As we get close to it, it fades away. In accord, there is a need for harmonious attention, effort, discomfort, and intellect. At much, a self-diagnosis and some imagination serve to make the infrastructural ways for global payment practical. As infrastructural ways are by no means an ending actionable outcome, for the reader having such an "aha" result, it is worth reflecting on it.

Beginning with the infrastructural way of granular homogenisation. Practically this finding means the accumulation of global payment services for specific granular needs. With the granularity of services, there will also be powerful standards for messaging formats. For organisations, this means opportunities for exploring new granular payment services or serving as payment aggregators and messaging standards for different global payment services. For regulators, this finding draws attention to their active participation in regulating private standards and the potential organisations that can develop those standards (e.g., global digital platforms). The need for this regulation also means a need for developing global public institutions that are inclusive in participation and actively regulate global organisations participating in global payment.

What the infrastructural way of irreversible validation practically implies is that the process of authentication in global payment services is becoming easier and easier to do. At the same time, there is more shared assurance, which makes changes in global payment transfers more difficult. For organisations, this finding means there is a need for actively developing reversible services that are open to different approaches for the fulfilment of compliance requirements. For regulators, this infrastructural way draws attention to the legal development of reversibility in global payment services, the endorsement and support of less formal ways for complying and auditing identifiable data (e.g., to be collected for the purpose needed in the right amount).

The infrastructural way of ubiquitous causation and its movement practically mean that global payment is more calculative while there also is constant inclusion of unforeseen payment services, which come with continuous accessibility. For organisations, the recommendation is that not everything can be calculated, and uncertainty needs to be present and managed. By allowing for further profitability with margins or developing alternative services that subsidise others, unforeseen payments and services may be managed and become lucrative. To regulators, the recommendation is to accept and support services that are not as predictable as others. Also, there

will be a need to develop new license categories and rework existing ones following the unforeseen inclusion of payments.

The last recommendations lie with the next three infrastructural ways along. First, hurtling means global payment services develop in a fast straight-line manner. For organisations, this infrastructural way and movement imply new flourishing opportunities to pursue where benefit arises from working with regulators. For regulators, this means there is a need to learn about different payment services and collaborate with unknown payment organisations. Next, swaying means global payment services develop in a back-and-forth manner. Here, the recommendation for organisations is to review and monitor their compliance and financial activities and collaborate with organisations offering different services. For regulators, there is a need to revisit existing frameworks and withdraw or recreate them to support organisations swaying back. Finally, rippling means global payment services develop in a waving manner. With this movement, the recommendation for organisations is to focus on niche services and invest in new projects, which may ripple beyond what was intended. For regulators, this movement implies a need for accepting outsider services and rapidly creating other legal frameworks to include them.

Table 12. Practical Implications of Findings		
Infrastructural Way	**So what?**	**Recommendations**
Granular Homogenisation	∞There will be new services that are more and more specific ∞There will be more standards that grow in complexity and power	**Heuristic Question** If the global payment infrastructure is granular homogenisation, what can and needs to be done? **Some suggestions for organisations** ∞Address global payment services serving specific needs such as left-out countries, services that seem unprofitable, and unforeseen services (e.g., to the metaverse) ∞Address connections between different types of (global) payments services ∞Focus on either specific payment services that connect with existing services or on connections that facilitate integrations among diverse payment services **Some suggestions for regulators** ∞Regulate large private global payment organisations behind ever-growing standards ∞Develop public standards ∞Develop global inclusive institutions to look after global standards
Irreversible Validation	∞There will be more ease for identifying payers and payees ∞There will be more shared assurance and difficulty in changing global payment	**Heuristic Question** If the global payment infrastructure is irreversible validation, what can and needs to be done? **Some suggestions for organisations** ∞Be open to changing requirements and different forms of compliance ∞Allow for changeable and reversible global payment services **Some suggestions for regulators** ∞Develop regulations that serve the reversibility of global payment services ∞Formalise informal institutions ∞Audit the collection and protection of people's identifiable information

Ubiquitous Causation	∞There will be more calculation in payment ∞There will be more participation in unforeseen payments	**Heuristic Question** If the global payment infrastructure is ubiquitous causation, what can and needs to be done? **Some suggestions for organisations** ∞Understand that not everything can be calculated ∞Manage uncertainty with cautions for the unknown (e.g., through profitable margins) **Some suggestions for regulators** ∞Accept services that are not as calculable (e.g., cash) as others (e.g., digital payment) ∞Develop new licenses that include different payment services ∞Rework existing license categories
Hurtling	There will be times of a straight-line fast development of global payment services	**Heuristic Question** If the global payment infrastructure is hurtling, what can and needs to be done? **Some suggestions for organisations** ∞Pursue flourishing opportunities ∞Work with regulators in new areas **Some suggestions for regulators** ∞Learn about different payment services emerging ∞Collaborate with unknown payment organisations
Swaying	There will be times of a back-and-forth development of global payment services	**Heuristic Question** If the global payment infrastructure is swaying, what can and needs to be done? **Some suggestions for organisations** ∞Review compliance and financial activities ∞Collaborate with established diverse organisations (e.g., banks)

		Some suggestions for regulators ∝Revisit existing regulations ∝Provide support for affected organisations
Rippling	There will be times of a waving development of global payment services	**Heuristic Question** If the global payment infrastructure is rippling, what can and needs to be done? **Some suggestions for organisations** ∝Focus on services at hand (e.g., a niche) ∝Invest in new and radically different projects **Some suggestions for regulators** ∝Accept new activities outside the existing framework (e.g., the outsiders that aren't complying nor breaking the law) ∝Improve legal frameworks that appear exclusive or non-encompassing

Conclusions on Infrastructure Development Along Ways

This thesis contributes an ontological approach addressing how the global payment infrastructure develops. As an ontological approach, along ways reveals movement as primary. Thus, the approach accounts for a persisting and changing infrastructure. Between these core findings, along ways helps revisit the scholarly tendency to isolate infrastructure development with the use of tensions, which overemphasises either persistence or change. The infrastructural ways for global payment bring a far more changing yet long-lasting infrastructure development with movement. Ethically, these infrastructural ways also complement prevailing views prioritising change in global payment infrastructure because they bring up continuity in an inclusive and non-conflicting manner with movement, which is natural and without transcendence. Thus, the non-linear continuities of infrastructural ways bring harmony, which can help manage breakdowns in the global payment infrastructure.

CHAPTER EIGHT

Closing Remarks on Movement in Infrastructure Development and Beyond

This study reveals movement in infrastructure development through an anomaly in the global payment infrastructure. The anomaly is that although the global payment infrastructure develops unprecedently, as it involves many payment relationships, the infrastructure takes time to develop. While useful, tensions in predominant research streams tend to isolate infrastructure development, leaving the development of the global payment infrastructure puzzling. As opposition and constraint, tensions bring up stasis, overemphasise persistence or change, and background movement in infrastructure development. To continue infrastructure studies, this work reappraises their philosophical grounds and presents assumptions for the natural coexistence and temporal existence of movement along ways. Following abduction principles, the study collects accounts of global payment organisations, historical reports, and narrative interviews documenting the global payment infrastructure from 1973 to 2030. The findings are infrastructural ways, which revisit the isolation of infrastructure development and address the development of the global payment infrastructure with movement. Although they are enticing and novel, the ideas presented in this study also are familiar and come with limitations, as this concluding chapter shows.

Limitations of Movement in Infrastructure Development

Movement is not novel. The subject is present in emerging old discourses in disciplines such as Philosophy (Nail, 2019), Anthropology (Ingold, 2000, 2021), Organisation and Management (Introna, 2019; Langley et al., 2013; Tsoukas & Chia, 2002), and Information Systems (Mousavi

Baygi et al., 2021; Pentland et al., 2017; Riemer & Johnston, 2017). One area of concern for this work is its quest for an ontological approach to movement in infrastructure development while there are present ones available. For example, Tomas Nail's philosophy of movement has Gilles Deleuze's ideas as background. This author challenges such ideas, e.g., assemblage, because they do not foreground movement as natural. Instead, Thomas Nail traces such movement as nature argument to an interpretation of the work of Lucretius, which revisits the understanding of matter as atomic. Similarly, Mousavi Baygi et al. (2021) draw upon the works of Tim Ingold to give a temporal and processual understanding, of ongoing becoming, to some of the notions addressing materiality in information systems that would follow from Actor-Network Theory.

While this study resonates with the above prevailing theories, it differs with its contextual and phenomena-driven focus on global payment infrastructure (Monteiro et al., 2022). Accordingly, this thesis differentiates from the philosophical works of Thomas Nail, which may background context, and the Vitalism grounds that may lie with process philosophy. Instead, this work stands alongside such views on movement by bringing anew and standing on the sociotechnical tradition that characterises the study of technology (Sarker et al., 2019), such as infrastructure. Nevertheless, the explicitness and clarity of how this work differentiates from others that address movement in different fields remain a limitation of this work.

In this vein, it is also worth noting that the works of Gregory Bateson and Martin Heidegger are present for studying technology in the information systems field and infrastructure studies (Ciborra, 2006, 2007; Ciborra & Hanseth, 1998; Márton, 2022; Reimers et al., 2022; Riemer & Johnston, 2017; Star & Ruhleder, 1996). For example, Riemer & Johnston (2017) build from Heidegger's analysis of equipment to clarify the usefulness of having an ontological inseparability between the social and the material in the study of information systems. Also, building from the works of Heidegger, Reimers et al. (2022) extend what Star and Ruhleder (1996, p. 114) mean when they note that "infrastructure becomes an unambiguous home — for somebody." Rather than a relationship between technologies and practices, infrastructure becomes a home for somebody based on Heidegger's arguments of thrownness in Being and Time, where people are already and always in a world. Inspiring and insightful, Márton (2022) recently brings to light ecological principles building from the works of Gregory Bateson to address the vast theoretical need to go beyond the bounds of the individual focus in information systems.

Indeed, the information systems field addresses Bateson's and Heidegger's works. Nonetheless, it is worth noting that this study critiques and rethinks these two scholars, albeit briefly. Thus, this work is not "pure" to their approach as previous studies may be. Positioning

such a critique within the information systems field and beyond, following a quest for movement in the study of technology, lies outside the scope of this manuscript and brings up another limitation.

More closely, there are methodological limitations. The narratives presented are overly grounded on four global payment organisations, and they also give evidence of such development being beyond these organisations, with movement along ways. In other words, the evidence of narrative and historical accounts negates and problematises the application of these organisations for unravelling infrastructure development (Timmermans & Tavory, 2012). Thus, this work problematises the case rather than looking for inferences that explain the case. It moves away from timelines and incidents but also organisations that tend to bring up structure and stasis over movement in infrastructure development. The result means moving away from empirically known approaches to analyse technology development, which brings up another limitation of this study. While abduction may give rise to innovative theoretical approaches, the rich empirical applicability of such approaches is less tangible than a factual inductive inference and a confirmatory deductive observation (Timmermans & Tavory, 2012). Some transferability, however, may apply to phenomena similar to the development of the global payment infrastructure. For example, the sociotechnical materialisation of renewable energy we are experiencing.

Continuing on the methodology, how the boundaries of the global payment infrastructure are defined could be more apparent. However, the global payment infrastructure is paradigmatic, and the essence of case study research is to maintain context with phenomena, not an identity. On this note, from the perspective of global payment infrastructure, an infrastructure part is no infrastructure. That is why the study of infrastructure development, for cases such as the global payment infrastructure, needs to depart from the bounds and comforts of defining a person, organisation, system, or country identity (e.g., Henfridsson & Bygstad, 2013). Intellectual progress lies with methodological innovation (Heidegger, 1977), where metaphorical narratives give a starting line. On this second note, this study draws inspiration from narrative analysis and abductive principles to address the case of global payment infrastructure. Practical and methodological limitations reside with the scope of the study (Avgerou, 2019), which is undefined and starts from global payments between people and particularly to developing regions. Thus, there is a flexible focus on global payment infrastructure underlying the largest source of foreign income in these countries, which implicitly backgrounds large commercial payments by corporations where the applicability of the infrastructural ways found may be limited.

Lastly, regarding the practical usability of infrastructural ways, backgrounding ends, as along ways does, may not serve short-lived outcomes or non-changing structures. Thus, this study's findings may not feel tangible or useful because there is no definitive outcome. However, this seems to be changing with climate change, pandemics, wars, and ever more prominent repercussions, which need an approach for revealing a reality that lies with movement rather than stasis. For example, suppose development, as approached by the United Nations, has some trueness (United Nations, 2015). In that case, it implies a different understanding of technology, such as infrastructure — one that is temporally long and inclusive.

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987, p. 41).

Further Questions Movement Raises

This study raises further questions on the study of technology. It gives a starting line for revisiting context, materiality, power, and ethics.

Following the case of the global payment infrastructure illustrates that context is inherent in phenomena and theory. A theory does not sit on a different plane (Bateson, 1972). This work also illustrates, at least in the case of global payment infrastructure, that context is continuous and with movement (Avgerou, 2019; Mousavi Baygi et al., 2021). Consequently, how we understand context also needs more research to move away from looking into a context that is immobile, surrounding, and present in that which is particular. Such theoretical advancements are particularly important in studying technology where the information systems field has experience. It is worth noting that these theoretical approaches advancing the understanding of context and technology are taking place in this field to address inclusion with technology (Kessel & Giraldo-Mora, 2023). Nevertheless, such a task lies ahead.

Technology's materiality is the second area where this work's notions of movement and infrastructure provide another starting line. Inspiring conversations around materiality in Information Systems foreground the human and technological nature of present and relevant phenomena (Orlikowski & Scott, 2008). What the understanding of this thesis does is support these views on sociomateriality, where the material and the social are inseparable. However,

questions remain about how materiality makes itself felt (Barad, 2007) and how materiality endures (Bhaskar, 1975). These questions follow the ontological approach of along ways, which foregrounds movement. Thus, there may be a process and ecological materialism rather than a revealing tension, happening, configuration, layer, or cut in materialisation. This area also deserves further work and attention.

Besides materiality, revisiting power and technology is a relevant study area. In Information Systems, power perspectives often end with a present critique and call for emancipation (Foucault, 1977, 1980; Myers & Klein, 2011). As a consequence, constructive and forward views of power, which come with movement, remain a need and a task. On this note, it is not the case that the individual has no agency and, therefore, no responsibility to act and change systemic power pressures (Foucault, 1977). As the individual is bigger than thought (Bateson, 1972), movement along ways brings a different conceptualisation for power and individual action. The individual is with history and others, which gives more power to the individual while also taking away coercive power.

Ethics is the last research area ahead, which builds on such a view of power. There is responsibility without guilt. Certainly, there is power and ethical action in letting go of technical objects because there is no will over things or technology (Heidegger, 1966; Introna, 2009). Nevertheless, there is a responsibility because one is bigger than thought and with others (Bateson, 1972) — following movement. Thus, a path lies ahead for addressing a forward-looking responsibility in the study of technology and today's digital transformation.

Final Remarks

This thesis reveals movement in infrastructure development. An ontological approach serves such a purpose and helps find the ways through which the global payment infrastructure develops. While this work has said much, there are some final remarks. For a (dis)continuous development, first, there needs to be an illusion that creates and comes from comfort. Tensions present such an illusion in infrastructure development. They arise with stasis, which leads to conflict, change, and persistence, but also and inevitably, a single pragmatic way out of reality. To the development of the global payment infrastructure, there is no such way out. It is larger than one thinks, and it is longer than one lives.

Appendices

Appendix A: Review Process for Chapter Two and Chapter Three

Review Process for Global Payment Infrastructure Histories in Chapter Two

The development of the bricolage of global payment infrastructure histories centres on payment between people across borders and currencies. The selection of histories follows the study of global payment organisations detailed in the chapter *Case Study of Global Payment Infrastructure 1973–2030*. Therefore, these histories concern today's organisations and go beyond their boundaries. This approach is helpful because the term "global payment infrastructure" is not institutionally established in research and history, despite its systemic importance. Furthermore, these histories document global payment infrastructure in today's Western and European areas, including the developing countries and regions that global payment reaches from these areas.

In addition, the development of this historical bricolage and infrastructure research streams detailed below follows Foucault's genealogical method. However, the review process also follows the theoretical values of this study, which centre on movement. In turn, the approach is less cutting than Foucault's genealogical history, as described in the following passage: "history becomes 'effective' to the degree that it introduces discontinuity into our very being — as it divides our emotions, dramatizes our instincts, multiplies our body and sets it against itself. 'Effective' history deprives the self of the reassuring stability of life and nature, and it will not permit itself to be transported by a voiceless obstinacy toward a millennial ending. It will uproot its traditional foundations and relentlessly disrupt its pretended continuity. This is because knowledge is not made for understanding; it is made for cutting" (Foucault, 1977, p. 88).

Accordingly, history books on money, such as Ferguson (2008), and searches for global payment infrastructure in Google Scholar and EBSCO gave an initial albeit limiting overview. Targeted searches in these databases allowed extending this limited overview with what global payment entails, which the study of global payment providers helped to clarify. These insights

drove the selection of historical accounts around instruments, ledgers, central banking, correspondent banking, telecommunication, central banking cooperation, payment cards, global payment standards, and digital payment instruments and ledgers. After that, snowballing together with insights from the study of global payment providers drove the search of past relevant references for the final development of global payment infrastructure histories. Albeit not encompassing, this final selection of histories gives context, introduces the global payment infrastructure, and provides evidence of its unprecedented and temporally long development.

Review Process for Infrastructure Research Streams in Chapter Three

With similarity, the review process for infrastructure research streams took place following a critical approach while considering the continuation, or movement, of this research rather than a present and cutting critique (Foucault, 1977). Further, this review begins with this study's anomaly, which is theoretical and empirical, following the study of organisations discussed in the chapter *Case Study of Global Payment Infrastructure 1973–2030*. While close to infrastructure studies, this anomaly and case also deviate from these. Accordingly, the review process of these streams first began with an overreaching search for infrastructure studies in the eLibrary of the Association for Information Systems, google scholar, and the journals MIS Quarterly and Journal of the Association for Information Systems. After that, additional references of articles found relevant for this study were added, including monographies, following a screening of present articles and their references.

This initial phase of the review process led to 126 manuscripts. From these, 37 manuscripts were selected based on their diverse representation of the literature and fields and relevance for addressing the development of the global payment infrastructure. After reading these 37 manuscripts, two scholars were found to give founding contributions that guide other scholars (Ciborra, 2006; Star & Ruhleder, 1996). The works of these authors were then assessed in detail and depth to understand where they come from. This process continued by diving into Martin Heidegger's and Gregory Bateson's philosophical works and pragmatism broadly viewed to make sense of how these influential studies on infrastructure developed.

Following Heidegger, Claudio Ciborra gave individuality and uniqueness to each infrastructure with endurance that often characterises past influence on current developments. This individuality occurred through Ciborra's study of risk and emphasis on the "imbrication of representations" (Ciborra, 2006, p.1339). Following pragmatism and the works of Gregory

Bateson, Susan Leigh Star centred on the formation of boundaries that make up infrastructure in practice. One of her notable works outlines such a view with the question, “when is an infrastructure?” (Star & Ruhleder, 1996, p.112), which, as Ciborra did, influenced further studies. Accordingly, this in-depth read of these two scholars led to an initial distinction between “enduring” and “fluctuating” infrastructure development.

These two distinctions guided another review of manuscripts. This last stage centred on understanding how subsequent articles followed the initial works and assumptions by Claudio Ciborra and Susan Leigh Star. The conclusion of this review process is the streams *endurance of structure* and *outcome for structure* presented in the chapter *Infrastructure Development*. It is worth noting that these streams are neither an exhaustive representation of infrastructure research nor the only ones. For example, infrastructure studies have a plethora of research following actor-network theory and complexity science.

Nevertheless, these streams illustrate predominant understandings that indirectly account for views presented by authors following on actor-network theory and complexity science. Also, the guiding emphasis on infrastructure vis-à-vis infrastructuring was intentionally avoided even though infrastructuring often is unduly associated to the works of Susan Leigh Star. The reason is that such distinction tends to opaque the complexities that lie with these two authors’ backgrounds, which the chapter *Infrastructure Development* aims to uncover.

Appendix B: Breakdown of Data

Table 13. Breakdown of Organisations Data			
Data Source	**Observations**	**Interviews**	**Documents**
Quick Remittance Services (QRS)	Participant observations (16 hours) Conversations with former CEO recalling 4 years of our past lived experience at the organisation (14 hours)	5 Interviews with CEO (300 min)	2,289 IT documents of which 493 (1000 pages) were for systems Integrations 2,459 Operations documents 3,428 Financial Documents 598 Legal Documents 32 Strategy Documents (90 pages)
Society for Worldwide Interbank Financial Telecommunication (SWIFT)	SIBOS 2018 Conference (20 hours) Other observations (25 hours)	Executive A (87 min) Executive B (73 min)	56 reports and 23 videos on instant payment services and the company's GPI project (450 pages, 220 Minutes)
Aryze	CEO Keynote Presentations and Discussion Session (3 hours)	Co-Founder (32 min) Co-Founder (64 min)	45 Company blogs and reports (261 pages)
MakerDAO	Keynote Presentations (2 hours) Online Company Meeting Recordings (8 hours)	CEO and Head of Product (Joint interview, 52 min) Foundation Chairman (65 min)	85 Company blogs and reports (348 pages)
Other Contextual Sources	International Association of Money Transfer Networks, 2017 London Conference (16 hours) Office Visits and Conversation with CEO at International Association of Money Transfer Networks in Copenhagen (14 hours) Blockchain in Banking, 2018 Copenhagen FinTech Lab Conference (2 hours) 3rd Nordic Blockchain 2018 Conference (3 hours)	CEO at Arabic remittance provider (33 min)	11 documents including reports and articles from the European Central Bank (722 pages) 14 documents including reports and articles from the World Bank (524 pages)

Table 14. Breakdown of Historical Data					
Data Code	**Author**	**Publication Year**	**Document Title**	**Publisher**	**Number of Pages**
BIS123	William A. Allen	1980	Exchange Rates and Balance-of-Payments Adjustments - General Principles and Some Recent Experiences	Bank for International Settlement	48
BIS29	Committee on Banking Regulations and Supervisory Practices	1987	Proposals for international convergence of capital measurement and capital standards	Bank for International Settlement	34
BIS41	Bank for International Settlement	1988	Prevention of Criminal Use of The Banking System for the Purpose of Money-Laundering	Bank for International Settlement	5
BIS40	Bank for International Settlement	1989	Risks in Computer and Telecommunication Systems	Bank for International Settlement	7
CBUS0	Alan Greenspan	1989	International Payment Systems Developments	International Symposium on Banking and Payment Services	16
BIS42	Bank for International Settlement	1990	Information Flows Between Banking Supervisory Authorities	Bank for International Settlement	10
BIS120	The Group of Experts on Payment Systems of the central banks of the group of Ten countries	1992	Recent Developments in International Interbank Relations	Bank for International Settlement	62
BIS119	C.E.V Borio and P. Van den Bergh	1993	The Nature and Management of Payment Systems: An International Perspective	Bank for International Settlement	86
BIS62	Committee on Payment and Settlement Systems	1993	Central Bank Payment and Settlement Services with Respect to Cross-Border And Multi-Currency Transactions	Bank for International Settlement	35
BIS57	Sean Craig, Robert Lindley and Paul Van den Bergh	1996	Implications for Central Banks of the Development of Electronic Money	Bank for International Settlement	16

Table 14. Breakdown of Historical Data					
BIS65	Committee on Payment and Settlement Systems and the Group of Computer Experts of the central banks of the Group of Ten countries	1996	Security of Electronic Money	Bank for International Settlement	64
BIS64	Committee on Payment and Settlement Systems of the central banks of the Group of Ten countries	1996	Settlement Risk in Foreign Exchange Transactions	Bank for International Settlement	65
CBUS1	Alan Greenspan	1996	Remarks on Evolving Payment Systems Issues	Journal of Money, Credit and Banking	6
BIS30	Basel Committee on Banking Supervision and the Offshore Group of Banking Supervisors	1996	The Supervision of Cross-Border Banking	Bank for International Settlement	26
BIS66	Committee on Payment and Settlement Systems of the central banks of the Group of Ten countries	1997	Real Time Gross Settlement Systems	Bank for International Settlement	43
BIS32	Basel Committee on Banking Supervision and the Offshore Group of Banking Supervisors	1998	Supervisory Cooperation on Year 2000 Cross-Border Issues	Bank for International Settlement	3
BIS68	Committee on Payment and Settlement Systems of the central banks of the Group of Ten countries	1998	Reducing Foreign Exchange Settlement Risk: A Progress Report	Bank for International Settlement	40

Table 14. Breakdown of Historical Data					
BIS122	Monetary and Economic Department	1998	Managing Change in Payment Systems	Bank for International Settlement	179
BIS72	Committee on Payment Committee on Payment and Settlement Systems	1999	Retail Payments in Selected Countries: A Comparative Study	Bank for International Settlement	33
BIS73	Committee on Payment and Settlement Systems	1999	Current Topics in Payment And Settlement Systems	Bank for International Settlement	58
BIS33	Basel Committee on Banking Supervision	1999	Year 2000 Cross-Border Communications between Supervisors during the Millennium Period	Bank for International Settlement	7
BIS34	Basel Committee for Banking Supervision	2000	Electronic Banking Group Initiatives and White Papers	Bank for International Settlement	25
BIS75	Committee on Payment and Settlement Systems	2000	Survey of Electronic Money Developments	Bank for International Settlement	93
BIS78	Committee on Payment and Settlement Systems	2000	The Contribution of Payment Systems to Financial Stability	Bank for International Settlement	76
BIS77	Committee on Payment and Settlement Systems	2000	Clearing and Settlement Arrangements for Retail Payments in Selected Countries	Bank for International Settlement	45
BIS79	Committee on Payment and Settlement Systems	2001	Core Principles for Systemically Important Payment Systems	Bank for International Settlement	92
BIS25	Monetary and Economic Department	2001	The banking industry in the emerging market economies: competition, consolidation and systemic stability	Bank for International Settlement	152
BIS26	Monetary and Economic Department	2001	Electronic finance: a new perspective and challenges	Bank for International Settlement	112

Table 14. Breakdown of Historical Data					
BIS82	Committee on Payment and Settlement Systems	2003	Policy issues for central banks in retail payments	Bank for International Settlement	48
BIS44	Monetary and Economic Department	2003	Regional currency areas and the use of foreign currencies	Bank for International Settlement	155
BIS35	Basel Committee on Banking Supervision	2003	Management and Supervision of Cross-Border Electronic Banking Activities	Bank for International Settlement	15
BIS81	Committee on Payment and Settlement Systems	2003	Policy issues for central banks in retail payments	Bank for International Settlement	48
BIS87	Committee on Payment and Settlement Systems	2004	Survey of developments in electronic money and internet and mobile payments	Bank for International Settlement	224
BIS90	Committee on Payment and Settlement Systems	2005	Central bank oversight of payment and settlement systems	Bank for International Settlement	55
BIS89	Committee on Payment and Settlement Systems	2005	New developments in large-value payment systems	Bank for International Settlement	84
BIS91	Committee on Payment and Settlement Systems	2006	General guidance for national payment system development	Bank for International Settlement	73
BIS126	Monetary and Economic Department	2006	Architects of stability? International cooperation among financial supervisors	Bank for International Settlement	25
BIS125	Monetary and Economic Department	2006	Almost a century of central bank cooperation	Bank for International Settlement	22
BIS46	Monetary and Economic Department	2006	Financial globalisation	Bank for International Settlement	53
BIS92	Committee on Payment and Settlement Systems	2006	Cross-border collateral arrangements	Bank for International Settlement	49

Table 14. Breakdown of Historical Data					
BIS124	Monetary and Economic Department	2006	One hundred and thirty years of central bank cooperation: a BIS perspective	Bank for International Settlement	36
BIS45	Monetary and Economic Department	2006	Past and future of central bank cooperation: policy panel discussion	Bank for International Settlement	22
BIS1	Committee on Payment and Settlement Systems, World Bank	2007	General principles for international remittance services	Bank for International Settlement	55
BIS93	Committee on Payment and Settlement Systems	2008	Progress in reducing foreign exchange settlement risk	Bank for International Settlement	84
BIS2	Committee on Payment and Settlement Systems	2008	The interdependencies of payment and settlement systems	Bank for International Settlement	77
CBEU1	European Central Bank	2009	Glossary of Terms Related to Payment, Clearing and Settlement Systems	European Central Bank	27
BIS36	Basel Committee on Banking Supervision	2009	Due diligence and transparency regarding cover payment messages related to cross-border wire transfers	Bank for International Settlement	13
BIS55	Basel Committee on Banking Supervision	2009	Due diligence and transparency regarding cover payment messages related to cross-border wire transfers	Bank for International Settlement	13
BIS37	Basel Committee on Banking Supervision	2010	Report and Recommendations of the Cross-border Bank Resolution Group	Bank for International Settlement	44
BIS94	Committee on Payment and Settlement Systems	2010	Market structure developments in the clearing industry: implications for financial stability	Bank for International Settlement	76
BIS95	Committee on Payment and Settlement Systems, Technical Committee of the International Organization of	2012	Principles for financial market infrastructures	Bank for International Settlement	182

Table 14. Breakdown of Historical Data					
	Securities Commissions				
BIS39	Basel Committee on Banking Supervision	2012	Capital requirements for bank exposures to central counterparties	Bank for International Settlement	13
BIS38	Basel Committee on Banking Supervision	2012	Monitoring indicators for intraday liquidity management	Bank for International Settlement	18
SW2	Susan V. Scott and Markos Zachariadis	2012	Origins and developments of SWIFT, 1973-2009	Business History	21
BIS96	Committee on Payment and Settlement Systems	2012	Co-chairs' summary note for the CPSS-IOSCO Principles for financial market infrastructures	Bank for International Settlement	8
BIS47	Committee on Payment and Settlement Systems and Technical Committee of the International Organization of Securities Commissions	2012	Principles for financial market infrastructures	Bank for International Settlement	182
BIS48	Committee on Payment and Settlement Systems	2012	Innovations in retail payments	Bank for International Settlement	90
BIS54	Basel Committee on Banking Supervision	2013	Literature review of factors relating to liquidity stress - extended version	Bank for International Settlement	24
BIS100	Committee on Payment and Settlement Systems,Board of the International Organization of Securities Commissions	2013	Authorities access to trade repository data	Bank for International Settlement	40
BIS27	Basel Committee on Banking Supervision	2013	Supervisory guidance for managing risks associated with the settlement of foreign exchange transactions	Bank for International Settlement	38

Table 14. Breakdown of Historical Data					
BIS58	Monetary and Economic Department	2013	Central bank finances	Bank for International Settlement	89
BIS56	Basel Committee on Banking Supervision	2013	Supervisory guidance for managing risks associated with the settlement of foreign exchange transactions	Bank for International Settlement	38
SW1	Susan V. Scott and Markos Zachariadis	2014	The Society for Worldwide Interbank Financial Telecommunication (SWIFT)	Routledge	162
BIS108	Committee on Payments and Market Infrastructures, Board of the International Organization of Securities Commissions	2014	Recovery of financial market infrastructures	Bank for International Settlement	29
BIS49	Committee on Payments and Market Infrastructures	2014	Non-banks in retail payments	Bank for International Settlement	44
BIS59	Committee on Payments and Market Infrastructures	2014	Charter	Bank for International Settlement	4
BIS3	Committee on Payments and Market Infrastructures	2015	Digital currencies	Bank for International Settlement	21
BIS115	Basel Committee on Banking Supervision	2015	Consultative Document, General guide to account opening	Bank for International Settlement	10
BIS104	Committee on Payments and Market Infrastructures, World Bank	2016	Payment aspects of financial inclusion	Bank for International Settlement	68
BIS106	Committee on Payments and Market Infrastructures	2016	Fast payments - Enhancing the speed and availability of retail payments	Bank for International Settlement	86

Table 14. Breakdown of Historical Data					
SW0	Harry Newman	2016	Linking interbank payment systems across borders and currencies: how easy is it?	SWIFT	4
BIS103	Committee on Payments and Market Infrastructures	2016	Clearing of deliverable FX instruments	Bank for International Settlement	2
BIS105	Committee on Payments and Market Infrastructures	2016	Correspondent banking	Bank for International Settlement	58
BIS107	Committee on Payments and Market Infrastructures	2017	Distributed ledger technology in payment, clearing and settlement	Bank for International Settlement	23
BIS116	Basel Committee on Banking Supervision	2017	Guidelines Sound management of risks related to money laundering and financing of terrorism	Bank for International Settlement	43
BIS52	Committee on Payments and Market Infrastructures	2018	Cross-border retail payments	Bank for International Settlement	41
BIS4	Committee on Payments and Market Infrastructures	2018	Central bank digital currencies	Bank for International Settlement	28
BIS109	Committee on Payments and Market Infrastructures	2018	Reducing the risk of wholesale payments fraud related to endpoint security	Bank for International Settlement	14
BIS117	Basel Committee on Banking Supervision	2018	Sound Practices, Implications of fintech for banks and bank supervisors	Bank for International Settlement	49
BIS53	Committee on Payments and Market Infrastructures	2019	Wholesale digital tokens	Bank for International Settlement	17
BIS5	Basel Committee on Banking Supervision	2019	Designing a prudential treatment for crypto-assets	Bank for International Settlement	14

Table 14. Breakdown of Historical Data					
BIS118	Basel Committee on Banking Supervision	2019	Report on open banking and application programming interfaces	Bank for International Settlement	19
BIS51	Committee on Payments and Market Infrastructures	2019	Investigating the impact of global stablecoins	Bank for International Settlement	31
BIS121	Financial Stability Institute	2019	Suptech applications for anti-money laundering	Bank for International Settlement	18
BIS110	Committee on Payments and Market Infrastructures	2019	Reducing the risk of wholesale payments fraud related to endpoint security: a toolkit	Bank for International Settlement	77
BIS50	Monetary and Economic Department	2019	The design of digital financial infrastructure: lessons from India	Bank for International Settlement	33
BIS114	Committee on Payments and Market Infrastructures, World Bank	2020	Payment aspects of financial inclusion: application tools	Bank for International Settlement	57
BIS113	Committee on Payments and Market Infrastructures	2020	Enhancing cross-border payments: building blocks of a global roadmap Stage 2 report to the G20 - technical background report	Bank for International Settlement	56
BIS28	Bank for International Settlement	2020	Central banks and payments in the digital era	Bank for International Settlement	29
BIS43	Bank for International Settlement	2020	Impending arrival - a sequel to the survey on central bank digital currency	Bank for International Settlement	15
BIS138	Group of Central Banks	2020	Central bank digital currencies: foundational principles and core features	Bank for International Settlement	21
BIS112	Committee on Payments and Market Infrastructures	2020	Enhancing cross-border payments: building blocks of a global roadmap, Stage 2 report to the G20	Bank for International Settlement	9
BIS111	Committee on Payments and Market	2020	Payment aspects of financial inclusion in the fintech era	Bank for International Settlement	74

Table 14. Breakdown of Historical Data					
	Infrastructures, World Bank				
BIS128	Monetary and Economic Department	2021	CBDCs beyond borders: results from a survey of central banks	Bank for International Settlement	19
BIS131	Committee on Payments and Market Infrastructures	2021	Extending and aligning payment system operating hours for cross-border payments	Bank for International Settlement	50
BIS148	Monetary and Economic Department	2021	Central bank digital currencies: motives, economic implications and the research frontier	Bank for International Settlement	30
BIS133	Committee on Payments and Market Infrastructures	2021	Developments in retail fast payments and implications for RTGS systems	Bank for International Settlement	30
BIS127	Monetary and Economic Department	2021	Multi-CBDC arrangements and the future of cross- border payments	Bank for International Settlement	17
BIS145	Monetary and Economic Department	2021	The Digitalization of money	Bank for International Settlement	35
BIS144	BIS Innovation Hub	2021	Project Jura - Cross-border settlement using wholesale CBDC	Bank for International Settlement	28
BIS149	Monetary and Economic Department	2021	Back to the future: intellectual challenges for monetary policy	Bank for International Settlement	26
BIS137	Financial Stability Institute	2021	Fintech and payments: regulating digital payment services and e-money	Bank for International Settlement	39
BIS147	Monetary and Economic Department	2021	What does digital money mean for emerging market and developing economies?	Bank for International Settlement	26
BIS142	Consultative Group on Innovation and the Digital Economy	2021	Enabling open finance through APIs Report on payment initiation	Bank for International Settlement	46
BIS134	Basel Committee on Banking Supervision, Committee on	2021	Review of margining practices	Bank for International Settlement	57

Table 14. Breakdown of Historical Data					
	Payments and Market Infrastructures				
BIS129	Committee on Payments and Market Infrastructures	2021	Implementation monitoring of PFMI: Level 3 assessment of FMIs‚Äô business continuity planning	Bank for International Settlement	33
BIS139	Committee on Payments and Market Infrastructures	2021	Central bank digital currencies for cross-border payments	Bank for International Settlement	34
BIS146	Monetary and Economic Department	2021	Non-bank financial intermediaries and financial stability	Bank for International Settlement	45
BIS136	Financial Stability Institute	2021	Supervising cryptoassets for anti-money laundering	Bank for International Settlement	24
BIS135	Financial Stability Institute	2021	Cross-border crisis simulation exercise in South America	Bank for International Settlement	23
BIS130	Committee on Payments and Market Infrastructures	2021	Application of the Principles for Financial Market Infrastructures to stablecoin arrangements	Bank for International Settlement	22
BIS141	BIS Innovation Hub	2021	Inthanon-LionRock to mBridge - Building a multi CBDC platform for international payments	Bank for International Settlement	72
BIS132	Committee on Payments and Market Infrastructures	2021	A discussion paper on client clearing: access and portability	Bank for International Settlement	20
BIS143	Group of Central Banks	2021	Central bank digital currencies: executive summary	Bank for International Settlement	5
BIS140	BIS Innovation Hub	2021	Nexus - A blueprint for instant cross-border payments	Bank for International Settlement	20

Table 15. Breakdown of Narrative Data				
Interviewee	**Length**	**Background**[32]	**Years of Experience**[33]	**Narrative Period**
INT1	79 minutes recorded 30 minutes not recorded (Virtual)	Director, product manager, and business development manager at global payment organisations	15	2008–2030
INT2	91 minutes recorded 240 minutes not recorded	Director and funder at global payment organisations	18	2004–2030
INT3	43 minutes recorded 15 minutes not recorded (Virtual)	Manager for European instant payment service implementations	10	2012–2030
INT4[34]	35 minutes recorded (Virtual)	Director and president in different global banks and payment network providers	20	2022
INT5	58 minutes recorded 10 minutes not recorded (Virtual)	Director, Board Member, Founder and Advisor at different global payment organisations	25	1997–2030
INT6	44 minutes recorded	Director at global payment organisations	10	2012–2022

[32] Some of these roles go cross different temporal periods at the following organisations: Barclays Bank, Citigroup, Crypto.com, Currencycloud, European Banking Authority, e-Money, Financial Conduct Authority, FIS, HSBC, IBM, Inpay, International Association of Money Transfer Networks, Mastercard, Nets Group, Open Banking, Ria Money Transfer, Ripple, Tempo, Titan Intercontinental, Vocalink, Western Union Financial Services, WorldRemit, among others.

[33] This count is with reference to the year 2022.

[34] Melissa Erissen and Philipp Maximilian Holder collected these data during one of their MSc degree research projects, which the author had the opportunity to supervise.

Table 15. Breakdown of Narrative Data				
Interviewee	**Length**	**Background[32]**	**Years of Experience[33]**	**Narrative Period**
	20 minutes not recorded (Virtual)			
INT7	27 minutes recorded 5 minutes not recorded (Virtual)	Advisor and technical specialist for global payment regulators	17	2006–2022
INT8	55 minutes recorded 15 minutes not recorded	Executive manager, and advisor at different global payment organisations	18	2004–2030
INT9	53 minutes recorded 10 minutes not recorded (Virtual)	Director, president, and manager at a global payment organisations	31	1991–2030
INT10	68 minutes recorded 10 minutes not recorded	Director and manager at a different global payment organisations	23	1999–2030
INT11	57 minutes recorded 7 minutes not recorded	Founder, Advisor, and Manager at a different global payment organisations	10	2012–2022
INT12	First Interview 57 minutes recorded 5 minutes not recorded (Virtual) Second Interview	Chairman, President, and Director at various global payment organisations	39	1983–2030

Table 15. Breakdown of Narrative Data				
Interviewee	**Length**	**Background**[32]	**Years of Experience**[33]	**Narrative Period**
	120 minutes recorded (Virtual)			
INT13	First Interview 42 minutes recorded. 5 minutes not recorded (Virtual) Second Interview 35 minutes recorded (Virtual)	Founder, Board Member, and Director at various global payment organisations	26	1996–2030
INT14	56 minutes recorded. (Virtual)	Founder, President, and Director at various global payment organisations	23	1999–2030
INT15	66 minutes recorded. (Virtual)	Director, Board Member, and Regional Manager at various global payment organisations	22	1999–2030
INT16	85 minutes recorded (Virtual)	Founder, Director, and Advisor at various global payment organisations	19	2004–2030
INT17	64 minutes recorded 10 minutes not recorded	Founder and CTO at a global payment organisation	10	2012–2030
INT18	83 minutes recorded. 7 minutes not recorded (Virtual)	Director and Vice President at global payment organisations	11	2011–2030

Table 15. Breakdown of Narrative Data				
Interviewee	**Length**	**Background**[32]	**Years of Experience**[33]	**Narrative Period**
INT19	91 minutes recorded (Virtual)	Director, President, and Founder at global payment organisations	35	1987–2022
INT20	83 minutes recorded 10 minutes not recorded	Director and Analyst at global payment regulators	24	1998–2030

Appendix C: Data Analysis Sample

Themes and their names changed during the analysis process. Following themes while narrating infrastructure, infrastructural ways unfolded. Therefore, these themes should not be read as "static" pictures of the analysis. Instead, they serve as grounded abstractions, which guided the writing of metaphorical narratives that present infrastructural ways.

Table 16. Analysis Sample for Global Payment Infrastructural Ways

Guidance	Retrospective Excerpts	Prospective Excerpts	Themes	Aggregate
Instrument for global payment	"a remittance transfer is likely to involve a "settlement chain" - a series of separate payments, each of which may be made differently" (BIS, 2007, p. 41; BIS1 Report) "cover payments are used by a bank to facilitate funds transfers on behalf of a customer to a beneficiary, most often in another country, but also in the same country when a foreign currency is used… the originator's bank may directly instruct the beneficiary's bank to effect the payment and advise that transmission of funds to "cover" the interbank obligation created by the payment order has been arranged through a separate channel" (BIS, 2009, p. 1; BIS36 Report)	"distributed ledger technology for payment, clearing and settlement activities can be designed in a number of ways and perform different functions… Some arrangements are based on updating balances in the ledger (that is, the ledger is recording positions through debits and credits). Some arrangements are based on transferring digital assets in the ledger (that is, the ledger is recording the transfer of ownership of a specific digital asset that exists only on the ledger). Yet other arrangements are based on transferring digital representations of a physical asset that is held in custody (ie the ledger is recording transfers of assets held elsewhere)" (BIS, 2017, p. 15; BIS107 Report)	Payment multiplicity	**Granular Homogenisation**

	"electronic payments, whether domestic or cross-border, require the exchange of electronic messages between payment providers and the other supply side actors involved in a payment. These messages typically identify the payer's and payee's (account) information, and the payment amount. Communication between payment service providers is typically conducted via dedicated networks, with SWIFT being the largest global network provider. In some instances, such as when an payment service provider is acting for both the payer and the payee or when a payment card is used, certain aspects of messaging may occur over a proprietary communication network" (BIS, 2018a, p. 12; BIS52 Report)	"a notable property of DLT is the distribution of responsibilities for updating the ledger by multiple nodes. These nodes can be deployed across multiple sites, institutions or even jurisdictions, as discussed later. Figure 1 provides a stylised depiction of the multiple nodes that update a ledger. In this example, all the nodes are connected and have their own identical copy of the ledger. Depending on the arrangement's rules, changes to the ledger can be reflected in all copies within a certain time span" (BIS, 2017, p. 3; BIS107 Report)	Payment messaging	
Regulation for global payment	"cross-border retail payments inherently encounter more legal and regulatory requirements than domestic payments… Licensing and oversight requirements may differ from jurisdiction to jurisdiction, especially regarding non-bank front-end and back-end providers. In certain jurisdictions, payment providers are required to obtain a financial licence (eg a specific money remitter licence or a licence as a bank or payment institution), while in other jurisdictions they are required to enter into an agreement with banks" (BIS, 2018a, p. 15; BIS52 Report)	"crypto-assets may rely on a public ('permissionless') ledger, whereby the validation of transactions can be done by any participating actor, or distributed among several actors or intermediaries, which could be unknown to the user base. In contrast, a private ('permissioned') ledger restricts and pre-defines the scope of validators, with the validating entities known to the user base" (BIS, 2019a, p. 7; BIS5 Report) "we see that, of course, we would need a corresponding bank that has a banking license and can process foreign exchange. So, we see it as—depending on which region or currency we are in, we would	Payment compliance	**Irreversible Validation**

		have to have a corresponding bank that can handle in that currency" (Aryze Interview)		
	"settlement finality is the legally defined moment at which the transfer of an asset or financial instrument, or the discharge of an obligation, is irrevocable and unconditional and not susceptible to being unwound following the bankruptcy or insolvency of a participant" (BIS, 2017, p. 16; BIS107 Report)	"In traditional systems, settlement finality is a clear and well-defined point in time, backed by a strong legal basis. For DLT arrangements, settlement finality may not be as clear. In arrangements that rely on a consensus algorithm to effect settlement finality, there may not necessarily be a single point of settlement finality. Further, the applicable legal framework may not expressly support finality in such cases" (BIS, 2017, p. 16; BIS107 Report)	Payment finality	
	"Payment-versus-payment (PVP) settlement is a mechanism that ensures the final transfer of a payment in one currency if, and only if, a final transfer of a payment in another currency occurs" (BIS, 2013, p. 31; BIS56 Report)	"contracts, and actions taken under contracts, should be legally enforceable with a high degree of certainty in all relevant jurisdictions even when a counterparty defaults or becomes insolvent. A bank should understand whether there is a high degree of certainty that contracts, and actions taken under such contracts, will not be subject to a stay beyond a de minimis period, voided or reversed. In jurisdictions where close-out netting may not be legally enforceable, banks should ensure that controls in place" (BIS, 2013, p. 23; BIS56 Report)		
Function for global payment	"at around 3:00 on 4 June 1991, SWIFT II regional processors 1, 2, 3, and 4 went offline and the SWIFT system was disrupted for four hours. As a result, user banks across Europe were unable to log on to the network and use its services. The financial press	"due to time zone differences, markets and payment systems in one jurisdiction might be closed when those in other jurisdictions are open. This naturally restricts the window during which funds can be transferred across jurisdictions, potentially	Payment risk	**Ubiquitous Causation**

	reported the incident as follows: Back-up processors could not be successfully activated. Finally, at about 07:30, there was a partial recovery allowing continental European banks back onto the network … but banks in the U.K., Ireland, the Channel Islands and Iceland remained cut off until nearly 16:00 in the afternoon. Several SWIFT II users missed CHAPS (Clearing House Automated Payments System) clearing deadlines as a result" (Scott & Zachariadis, 2013, p. 40; SW1 Report) "SWIFT users are grouped into three categories, each of which has access to different levels of service from SWIFT: supervised financial institutions can send and receive all types of messages; non-supervised entities active in the fi nancial industry can send all type of messages to supervised financial institutions but cannot send or receive payment messages to or from other non-supervised entities; and closed user groups and corporate entities have access to services as defi ned by the administrator of the closed user group or, for corporate entities, according to criteria defined in the relevant service" (Scott & Zachariadis, 2013, p. 32; SW1 Report)	resulting in slower settlements. This risk can be addressed by opening domestic systems for longer, as is happening in some jurisdictions. In addition, the adoption of fast payments that allow retail customers to transfer money 24/7 with immediate reusability of funds increases the demand for longer operating windows for wholesale payment systems, in part to address demands for payment in off-hours in excess of funds on deposit" (BIS, 2019c, p. 7; BIS53 Report) "cross-border reach: Digital currencies based on distributed ledgers are basically open networks with a global scope. These schemes do not distinguish between users based on location, and therefore allow value to be transferred between users across borders. Moreover, the speed of a transaction is not conditional on the location of the payer and payee. Further, in the context of restrictions that may be placed on cross-border transactions by national authorities, • the decentralised nature of these digital currency schemes means that it is difficult to impose such restrictions on transactions" (BIS, 2015, p. 10; BIS3 Report)	Payment ubiquity	

Table 17. Analysis Sample Along Global Payment Infrastructural Ways				
Initial Guidance	**Retrospective Excerpts**	**Prospective Excerpts**	**Themes**	**Aggregate**
Instrument *and* Regulation for global payment	"in the 1990s, SWIFT was drawn into discussions about identifying and tracking illegal activity. Lenny Schrank recalls that one of his first meetings after becoming CEO of SWIFT in 1992 was with Alexander (Alex) Karrer from the policy-making body Financial Action Task Force (FATF): 'At that time they were worried about drug money and money laundering, and wanted to work with SWIFT to improve our standards so that investigation would be easier. They wanted to work with myself and the Board rather than the members' user groups to tighten up on blank fields in payment standards and hoped that SWIFT would want to cooperate. This was when we first began to think the unthinkable: that maybe we have some data that the authorities would want, that SWIFT data would be revealed … and what to do about it … So we laid the basis in 1992 for how we deal with this … no one thought about terrorism at that time'" (Scott & Zachariadis, 2013, p. 128; SW1 Report) "The FATF were interested in SWIFT because a large volume of worldwide cross-border financial transactions pass through SWIFT and they wanted to explore the possibility of using that financial data (SWIFT messages) to trace illegal activities.	"In addition to more efficient and safer payments and settlement systems, CBDC could come with additional benefits. Given that a CBDC can allow for digital records and traces, it could improve the application of rules aimed at anti-money laundering and countering the financing of terrorism (AML/CFT), and possibly help reduce informal economic activities" (BIS, 2018b, p. 9; BIS4 Report) "when you make an API integration sometimes you can only send the transaction. And that's it. There is nothing more. After certain amount of money and you need to provide further information from the sender and probably provide documents that legally support the transaction. Sometimes you don't use the same API integration to communicate. When the transaction is online, you send the other party information in real time, but then they complain by email or by other means of communications, which slow down the whole process. The challenges are how you can integrate all these [data] together" (INT1 Interview)	Standard change	**Hurtling**

	During the course of their discussions with the FATF in the 1990s, following an initial approach from the US government, SWIFT asserted that they were not allowed to disclose the content of SWIFT messages (bank data) to third parties and explained that data were only kept for a limited time. SWIFT nonetheless decided that it was appropriate to address broader concerns regarding the SWIFT message template, which at this time did not have a specific field to include originator's data. This field was subsequently included and made mandatory in the message standard, which means that its omission will cause the SWIFT system to reject the message" (Scott & Zachariadis, 2013, p. 128; SW1 Report)			
Regulation *and* Function for global payment	"regulation is aimed at preventing or correcting "market failures" in the provision of the services - ie circumstances which, if the market were left to function by itself, would result in a suboptimal outcome. Some payment providers also offer other services as well as remittances (eg they may take deposits and give credit) and may be subject to more intensive regulation because of these services; depending on how they set their prices, they may therefore be more expensive than an payment provider that offers only remittance services" (BIS, 2007, p. 17; BIS1 Report) "because remittance services are offered by many different types of service providers, a functional rather than institutional	"GPI is not only a solution but a framework whereby banks need to confirm the posting to the beneficiary within 24 hours. [This] means that today we've seen a drastic improvement in customer experience. We've seen that 40% of cross-border payments on the SWIFT Network are confirmed within five minutes" (SWIFT Observation) "an autonomous system of smart contracts specifically designed to respond to market dynamics together with the decentralized governance from the MKR owners" (MakerDAO Documentation)	Regulatory enactment	**Swaying**

	framework may be desirable to minimise different treatment of service providers offering similar services. However, often this may be impractical: many countries already have different bodies of law and regulations applying to different types of RSPs, and changing this would be difficult. For example, bank RSPs and non-bank RSPs may be governed by different, well established legal and regulatory frameworks. Where this is the case, the underlying principle can be met instead by ensuring that equivalent rights and obligations exist regardless of which body of law applies to an institution. For example, the know-your-customer requirements for remittances should be the same for banks and for non-bank RSPs even if they are governed by separate regulations" (BIS, 2007, p. 24; BIS1 Report) "In today's international context, there is a key difference in the resolution of these liquidity and supervisory issues. The creation of a supra-national central bank or supervisory authority is seldom put forward as a policy option. The serious consideration being given to creating such new institutions within the European Community is an important but limited exception. Instead, some form of international cooperation is usually needed to find solutions to common problems" (CBUS0)	"unrestricted arrangements could open up services to new types of participant and reduce the tiering of relationships in payment, clearing and settlement processes. However, unrestricted access might cause scalability and information security issues because of the inherent challenges of reaching consensus between large numbers of participants that are unknown to each other. Anonymous participation also calls for security measures mitigating cyber-attacks or illicit activities to be incorporated into the design and rules of the arrangement (that is, to be resolved "onledger"). These issues are significant enough that current DLT implementations for payment, clearing and settlement activities are focused on restricted arrangements, which more closely fit within existing legal and regulatory frameworks. Assigning particular roles to a broad range of entities and their nodes may introduce other important issues. For example, if only certain nodes are delegated to achieve consensus, it may be easier (and faster) to reach consensus on the state of the ledger; however, it may also be easier for any one of these nodes to compromise the integrity of the ledger. Thus, it is important that such an entity is known and trusted by participants" (BIS, 2017, p. 9; BIS107 Report)		

Function *and* Instrument for global payment	"None of the money markets in the traditional world work 24/7. So, for example, if you look at the Euro market, the Euro market works in the euro time zone, right? Again, markets work in Yen times zone, US dollar markets work in US dollars (...) they have different holidays. They are closed, opened (...) So, if you want to send 60 money to Yen, because the time zones are different, you cannot do the trade during in which both markets are open. So, essentially the banks need to have a pre-funded position to transfer that 100 euro to US dollar because a lot of time the markets are not open for them to do the trade in real time, right? For example, if we were trading bananas for apples, like you know in a normal market, and all four of us are in the same time zone, that is easy, right? You essentially can do instant trade bananas for apples, or for oranges, because we are all four in the same marketplace, we are all standing next to each other, and the trading can happen (...) but if the markets are closed(…), then you have this time gap and the time gap creates, lots of issues (…) if another institution fails what happens to your money, if the FX range fluctuates, what happened to this money and things like those? So the number of variables, that essentially comes in, makes the market inefficient" (INT4 Interview) "in an open service, there is no direct contact or negotiation between the payment providers involved and so the capturing payment provider has limited control over	"Now, let me come to blockchain and then I will come to Ripple together. So, in the blockchain, one of the greatest things about blockchain is not so much that it is blockchain, but blockchain operates in markets which are 24/7, right? So, bitcoin operates 24/7, the US dollar bitcoin period is 24/7, yen with Bitcoin is 24/7. So for the first time in the world you have got bitcoin, which essentially is a 24/7, a system, which is available to anybody at any time. But also the trading happens 24/7, which means in real time milliseconds transfer bitcoin to you and I" (INT4 Interview) "one of the things that GPI enables, in the domain of Nostro reconciliation, is the concept of unique end-to-end transaction referencing. This is important because [without such referencing] it becomes very difficult indeed to do the transaction-based reconciliation on the shared ledger. So, the idea that every correspondent banking transaction should be a GPI transaction, meaning it has a unique end-to-end transaction reference, is actually a prerequisite to successfully transition to sharing ledgers rather than sending them to each other" (SWIFT Observation) "the use of stabilisation mechanisms linked to reference assets, which in principle aim to minimise fluctuations in the value of crypto-assets. Examples of such stabilisation tools include: (i) funds	Boundary remaking	**Rippling**

	the speed of the process. Indeed, the service is likely to be relatively slow. Because of the lack of a relationship with the capturing payment provider, information about the remittance travels only with the funds, so the disbursing agent usually cannot pay out before it has been paid. Speed is thus determined by how fast the settlement process is (which is likely to be at least several days under most normal banking processes). Moreover, intermediary banks may sometimes hold onto the funds for a period before forwarding them so that they can benefit from the resulting 'float.' However, set against this loss of speed, and the lack of transparency mentioned above, open services have the significant advantage of almost unlimited global coverage" (BIS, 2007, p. 12; BIS1 Report)	held by the issuer or a custodian that back the crypto-asset and are fully redeemable; and (ii) other asset classes (including crypto-assets) that back the crypto-asset, and which are held by the issuer, a custodian or recorded in a decentralised manner" (BIS, 2019a, p. 6; BIS5 Report)		

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