SSATP Africa Transport Policy Program

PPIAF Enabling Infrastructure Investment

INNOVATION IN FARE COLLECTION SYSTEMS FOR PUBLIC TRANSPORT IN AFRICAN CITIES

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// Acronyms

5G	5th generation mobile network
AFCS	Automated Fare Collection Systems
AFD	Agence Française de Développement
AfDB	African Development Bank
AFS	Automated Fare System
AMT	Maputo Transit Authority
APS	Application Program Interfaces
ATM	Automated Teller Machine
AUC	African Union Commission
AVLS	Automated Vehicle Location System
BRT	Bus Rapid Transit
DP3	SSATP Third Development Plan
EC	European Commission
EFTPOS	Electronic Funds Transfer at Point of Sale
EMV	Europay, Mastercard, Visa
ES	Executive Summary
ETA	Estimated Time of Arrival
ETIMs	Electronic Ticketing Machines
EU	European Union
FPaaS	Fare-Payment-As-A-Service
GDP	Gross Domestic Product
GPS	Global Positioning System
GSMC	Global System for Mobile Communications
HSBC	Hongkong and Shanghai Banking Corporation Limited
ICT	Information and Communication Technology
ID	Identification
ISO	International Standards Organization
IT	Information Technology
ITS	Intelligent Transport Systems
JICA	Japan International Cooperation Agency

KYC	Know-Your-Customer
LAMATA	Lagos Metropolitan Area Transport Authority
LVP	Low Value Payment
MNO	Mobile Network Operator
MTN	Mobile Telephone Network
NaMATA	Nairobi Metropolitan Transport Authority
NDoT	South Africa National Department of Transport
NPCI	National Payments Corporation of India
OECD	Organisation for Economic Co-operation and Development
PBOC	The People's Bank of China
PIN	Personal Identification Number
POS	Point Of Sale
QR	Quick Response
REC	Regional Economic Communities
RURA	Rwanda Utilities Regulatory Authority
SACCO	Savings and Credit Cooperative Organizations
SANRAL	South African National Roads Agency SOC Ltd
SECO	Swiss State Secretariat for Economic Affairs
SMS	Short Message Service
SSA	Sub-Saharan Africa
SSATP	Africa Transport Policy Program
TfL	Transport for London
TIPS	TARGET Instant Payment Settlement
UK	United Kingdom
UNECA	United Nations Economic Commission for Africa
UPI	Unified Payments Interface
US	United States of America
USSD	Unstructured Supplementary Service Data
UTM	Urban Transport and Mobility
WB	World Bank

EXECUTIVE SUMMARY

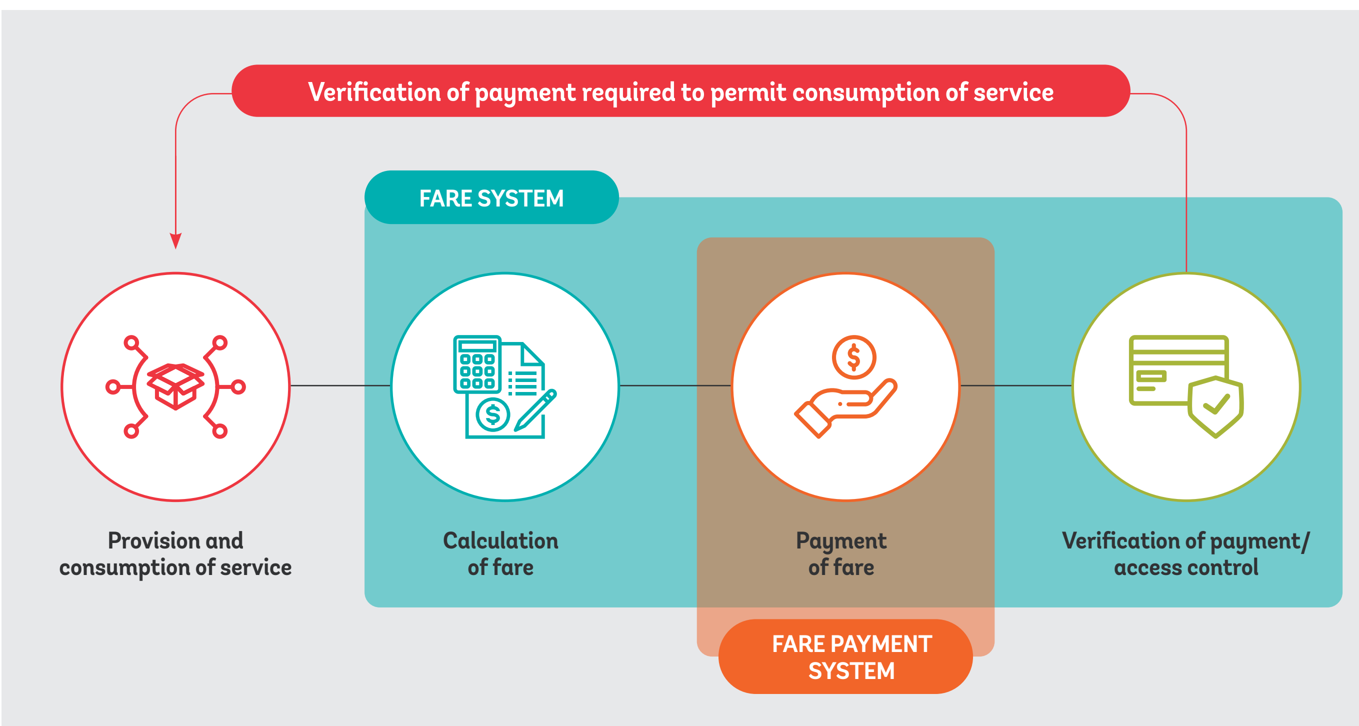
// Introduction

This study of African fare payment systems seeks to understand the emerging payment landscape in public transport in Sub-Saharan Africa, identifying key trends and their implications. The research draws on case studies undertaken in five African cities—Cape Town, Kigali, Lagos, Maputo and Nairobi—selected to cover a variety of contexts, innovations and language regions. A sixth case is included from India, identified through a wider international scan and which embodies some significant innovations relevant to the African context.

// The functions of fare systems

Not all automated systems in fare payment perform the same functions. Payment of the fare itself is only one of three broad functions of a complete fare system—the others being the calculation of the fare, and control over access to the transport service (Figure ES-1).

// **Figure ES-1**
Components of a complete fare system.



// Fare system technologies

Automated fare systems use a variety of approaches; and these are changing as technology changes. Closed-loop systems function independently of the wider world of electronic payment transactions, using payment media that can be used only on that system, although value will need to be loaded from that wider world. In contrast, "open" systems can accept payment from devices that are independent of the fare payment system, such as a bank's debit and credit cards.

Systems are described as account based where individual user accounts are held in a back office and a card or another device is used to record the user's movement through the system and deduct the fare. Systems can be card-centric where information is held primarily on the card and value is deducted from it through the exchange of information between the card and a validator as the card is swiped or tapped on the system. Conversely, in back office-centric systems most of the information is held in the back office, and the card or another device serves primarily as an identifier that tells the back office of the user's movements, with the back office applying fare rules to calculate the fare and charge the user's account.

// The wider payment context

Fare systems exist against a backdrop of wider technological development in payment systems. Card- based public transport fare systems emerged from the technologies developed by the credit and debit card industries. As contemporary technologies have advanced, the mobile phone has begun to replace card-based payment systems.

Globally, the first significant use of mobile phones to make payments was developed in Kenya with the M-Pesa system. The technology that was used to send airtime credit between mobile phones was reconfigured into a system to transfer money. Payments using mobile phones have become much more ubiquitous, driven, in particular, by developments in China, but now extending globally. Unlike card-based systems, with mobile smartphone transactions the seller need only have a cheap, printed QR code, with the buyer's phone providing connectivity with the financial back office.

While card systems dominate fare payment technologies in Africa, the use of mobile phones for this purpose has increased.

// Three key dimensions

This study has examined the trends in fare systems in Africa from three key perspectives. The first is a technological perspective, while the second is concerned with organizational and institutional issues. The third is about the mainstreaming of paratransit, which – while it can arguably be regarded as an organizational issue – has been identified as a discrete dimension of change because of its importance as a key issue in public transport discourse in Africa (Figure ES-2).

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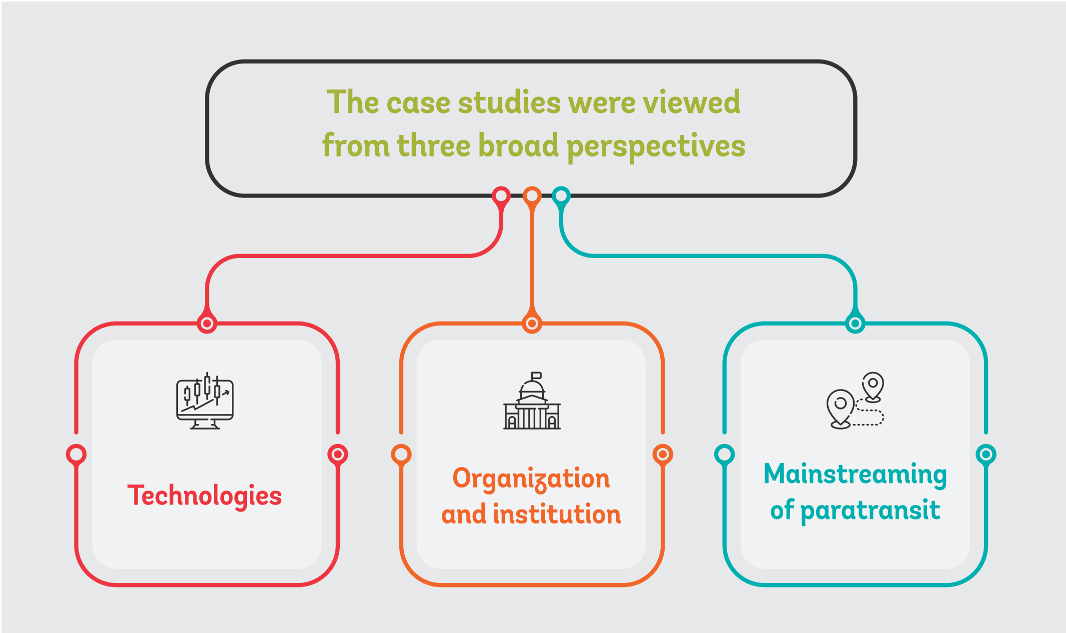
Figure ES-2
Three dimensions in fare systems in Africa.



// A few key themes and insights have emerged from this study

ARE AUTOMATED FARE SYSTEMS WORTH IT?

It is widely assumed that automated fare systems are superior to cash-based systems and that modernization is needed. However, when introducing new automated fare systems to replace cash systems, it is important to be clear about the envisaged objectives.

The key arguments for the introduction of automated fare systems are:

- They can enable quicker boarding, improving journey times and bus use efficiency.
- They can help curb fare evasion, fraud and the scope for theft of cash from vehicles.
- Staff requirements for handling on-board cash payment are reduced.
- An automated system is a rich data source, which can be used to improve services, better tailoring supply to demand.
- By making cashflows much more transparent, they can improve the bankability of transport projects.
- They are more convenient for the user.

These are strong arguments. However, automated fare systems can be expensive when all the various cost elements are included, and the benefits may not always exceed the costs. Where margins are low the additional cost of implementing an automated fare system may be challenging for a bus operator to bear (Box ES-1).

//
Box ES-1
Key takeaways:
Automated fare systems

KEY TAKEAWAYS

- Clarity about the objectives and realism about all the potential costs and benefits are essential when introducing a new automated fare system.
- Cash remains the most convenient medium for many users.
- The generation of data by the fare system is arguably the most important benefit so long as this is actually used to optimize the system and improve bankability.
- Fare systems are likely to add most value where the interests of the fare system owners are well aligned with improving the effectiveness of the transport business overall.

WHAT ARE THE MOST SIGNIFICANT TECHNOLOGICAL TRENDS?

While fare payment in Africa remains largely cash based, electronic systems are being introduced mostly as card-based systems. Among the case studies, the introduction of smartcards include the developments highlighted in Cape Town, Kigali, Lagos and Maputo. Repeated attempts to introduce card-based systems in Nairobi have been unsuccessful, including a new attempt that emerged while this project was underway; however, Nairobi has seen a gravitation toward payment using mobile phones, driven in particular by the popularity of M-Pesa. Many of the card systems can be loaded using mobile money, such as M-Pesa or its equivalents.

Mobile data phones or smartphones offer much greater scope than card systems. While cards enable the digitization of transactions, making much better data available to the operator and helping reduce leakage, the mobile phone offers the potential for a rich two-way flow of information between users and the system (Box ES-2).

KEY TAKEAWAYS

- Mobile phones have the potential to offer much wider functionality than smartcards, enabling direct communication with the user; and are beginning to be used for fare payment in Africa.
- However, many users do not have suitable phones or are not comfortable using them as a device for automated fare payment systems other than to make ordinary mobile money payments to the conductor as a substitute for cash; the majority of automated fare systems are card based.
- Initiatives to introduce back office-centric, account-based systems are not yet proven in the African environment.

Box ES-2 //
Key takeaways:
Significant technological trends

IS IMPLEMENTING A NEW FARE SYSTEM PRIMARILY A TECHNOLOGICAL CHALLENGE?

In the implementation of an automated fare system, new technology tends to draw the most attention. However, technological change is not just about the tools and machines but rather how these are used in conjunction with changed business processes and organization. These, in turn, nest within a set of institutional arrangements. Some would argue that there is a need to broaden the concept of technology from tools and machines to ways of doing things.

A key issue is who bears revenue risk. Those bearing the most risk have the greatest incentive to ensure that the system works successfully. This, in turn influences how control over a fare system needs to be configured. But if a fare system service provider is paid based on the number of transactions, then the provider is fundamentally invested in overall ridership levels—a matter over which the provider may have limited control.

A fare system provided and operated by a specialist third-party provider is clearly an appropriate model under a variety of circumstances; however, this approach is still relatively new. One of the challenges is that while the tools and equipment may be standard, the context within which they must operate may vary substantially, requiring flexibility and adaptability on the part of the fare-payment-as-a-service (FPaaS) provider. At the same time, vehicle operators or transport authorities which employ such service providers need to develop the skills to be able to manage them, allocating responsibilities, risks, and rewards appropriately.

How fare systems are organized is not just a technology issue—or a fare systems efficiency issue —but a fundamental element in how institutions, incentives, and power relations governing the delivery of public transport are constructed. Indeed, a significant risk prevails in that initiatives to modernize fare systems fail to pay sufficient attention to these institutional dynamics (Box ES-3).

KEY TAKEAWAYS

» Fare systems are a fundamental element in how transport operations work and affect incentive structures and power relations in the organization of public transport delivery.

» The implementation of new fare systems is therefore much more than a technological challenge.

» The design of a fare system must align with how revenue risk is configured.

» Fare systems are likely to add most value if relationships are structured so that the interests of those designing and implementing the fare system are well aligned with improving the effectiveness of the transport business overall.

// **Box ES-3**
Key takeaways:
Implementing a new fare system

CAN PARATRANSIT SYSTEMS BE IMPROVED BY INTRODUCING AUTOMATED FARE SYSTEMS?

While significant financial resources and effort have been directed toward the formal public transport sector across Africa over the years, the informal paratransit sector carries a higher number of passengers than formal public transport in almost every African city. The sustained success of the paratransit sector, which typically operates without any subsidies, is leading to increasing recognition of its importance, and greater awareness that transit strategies need to build on this success rather than replace it with more expensive formal solutions. The introduction of electronic fare systems into paratransit is often seen as a key mechanism to do this; however, this has been largely unsuccessful.

While a range of incremental improvements are possible in the paratransit sector, the critical step in improving efficiency arises when the collective fleet is able to respond to demand with an appropriate, data-driven service plan that maximizes average load factors. However, this is not possible when each vehicle continues to earn based on the number of passengers it carries. Instead, fares need to be pooled to remove the perverse incentives that undermine collective efficiency.

The introduction of an automated fare system can assist significantly in making this fundamental shift, not only by helping avoid the practice of the driver taking the fare, but also by enabling transparency among all owners as to the total fare income earned. However, it is insufficient on its own; it needs to be part of a wider set of changes supporting a changed business model. Indeed, unless well integrated with such a wider strategy, limited benefit can be anticipated from the introduction of automated fare systems in the paratransit sector; and they are unlikely to work, predominantly because of driver–conductor resistance (Box ES-4).

KEY TAKEAWAYS

- Paratransit is by far the most successful form of public transport in Africa, measured by number of trips and accounting for the majority of trips in almost all African cities.
- Significant improvement of paratransit requires changing the business model to enable collective rather than individualized management of the fleet while maintaining the drive toward serving passengers' trip needs.
- Automated fare systems can enable change, but are likely to fail if not implemented in ways that address the power relations and incentive structures between drivers, operators, and passengers.

Box ES-4 //
Key takeaways:
Improving paratransit systems

WHAT ROLE SHOULD GOVERNMENT PLAY IN THE AUTOMATION OF FARE SYSTEMS?

The appropriate role of government will vary in different contexts. One of the challenges in much of Sub-Saharan Africa is the limited institutional capacity of governments combined with comparatively low levels of compliance with rules and regulations. Informality is the dominant, prevailing mode. In this context, private initiative is important; and endeavors that do not build on the drive and entrepreneurialism of the private sector may have a limited chance of real success. Nevertheless, a supportive public sector is also critical.

Having a single, city-level authority responsible for public transport with jurisdiction over the whole urban area seems to be a key element in developing appropriate public sector strategies for automated fare systems—as indeed it is for managing urban public transport generally. Central governments often have the resources and the political power to initiate significant new programs, but do not have the focus and engagement with the complexities of mobility across the local urban environment that a city-wide institution will have; and they can easily become motivated by extraneous concerns.

Public authorities must appreciate that they are often not well placed to understand how fare systems are embedded as an integral part of the bus business, and need to resist imposing technological solutions from the outside; instead, they should find ways of responding to bus operators' needs. Acting strategically requires significant skills, particularly in understanding: (i) how to regulate within an environment that does not usually adhere to regulations; (ii) how to apply limited resources in ways that bring substantial returns; and (iii) how to work with private sector operators - including the informal sector - in optimizing the public good (Box ES-5).

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Box ES-5

Key takeaways:
Role of the Government

KEY TAKEAWAYS

- » The national or central government often has the resources and political power to initiate significant new programs, but may not be well placed to understand the complexities of running public transport. It can be easily motivated by extraneous concerns; while exceptions are possible, national or central government should play a broadly supportive role rather than get involved in system design and detail.
- » City-wide municipalities or transport authorities, which are key to the success of public transport systems in general, can play a critical role in facilitating alignment between fare systems and the wider system whereby underpinning that success.
- » A key challenge for such authorities in supporting effective fare systems lies in aligning the creativity and competitive drive of private interests with delivering city-wide public benefits based on multiple modes and focused strongly on the public transport user.


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1. INTRODUCTION

1.1 // Purpose

This study of African fare payment systems seeks to understand the emerging payment landscape in public transport in Sub-Saharan Africa, identifying significant trends and drawing key conclusions. The study draws on five detailed African case studies selected to cover various contexts, language regions and innovations; namely, Cape Town, Kigali, Lagos, Maputo and Nairobi. After a wider international scan, a sixth case study from India, embodying some significant innovations relevant to the African context, was included in the analysis.

The study is based on a limited number of cases and therefore, cannot claim to be comprehensive or definitive of the highly varied African context. However, the identification of key trends and the conclusions drawn should offer a useful basis for reflection and debate among practitioners and researchers. While the focus is on Sub-Saharan Africa, the insights are likely to be of relevance to the contexts of other developing countries.

1.2 // Background

Traditionally, fare systems have been viewed as a core activity of public transport service providers. However, fare systems are undergoing significant change, reflecting a transformation and disruption in the broader society as to how people pay for and receive many goods and services.

Globally in the transport sector, the two fundamental transactions—user pays and service provider receives—are increasingly being decoupled. New players, who are typically non transport actors, are positioning themselves in the payment chain between the users and the providers of transport services. Fare collection activities are increasingly being carried out by third parties. This comprises not only the outsourcing of some tasks, but also full concessioning or the provision of end-to-end activities as a service. Technology is increasingly being provided either by third parties or the users themselves, with greater use of smartphone applications and remote transactions replacing traditional public transport specific devices and transforming user and provider behaviors. The primary customer relationship is increasingly with the application manager, micropayment provider, or bank, which then develops a business-to-business relationship with the public transport agency or operator.

While most public transport fares in Africa are still paid using cash, the continent has been a hotspot in the rapid growth of micropayment services, mobile and smartphone-based transactions and the supporting technical, sales and administrative platforms. Once these payment mechanisms gain a reasonable level of penetration in general society they become of interest to the public transport sector, which has a high level of cash transactions coupled with a high level of revenue leakage.

The Africa Transport Policy Program (SSATP) assists member countries with developing more comprehensive policies and designing efficient strategies for the promotion of sustainable mass transport systems, including through the use of new technologies. This report seeks, therefore, to offer insights into the emerging fare payment landscape and identify lessons that may be relevant to SSATP member countries in the implementation of new fare collection systems.

1.3 // Structure of this report

The initial chapters in this document (chapters 2, 3 and 4) aim to establish a common terminology and conceptual understanding of the terrain against which the case studies are examined and lessons drawn (chapter 5, 6 and 7).

While there is a short summary of the case studies in chapter 5, most of the case study material is available separately, including a summarized report of all the case studies, along with the detailed report for each city.

CHAPTER 2

EXPLAINS KEY DEFINITIONS, CONCEPTS AND DEVELOPMENTS IN FARE COLLECTION

As traditional fare systems using coins and notes have been replaced by electronic payment systems of various kinds, and as this technology has developed, fare collection has become increasingly technically complex and varied. This section explains the most important technological concepts in simple terms. It starts by identifying the three key components of a fare system—fare calculation, fare payment, and access control—before discussing the technology itself. Fare technologies which only replace one of the components cannot be directly compared with those that replace all three.

CHAPTER 3

IDENTIFIES RELEVANT DEVELOPMENTS IN PAYMENT TECHNOLOGIES GENERALLY

The replacement of coins and notes in public transport is part of a much wider shift toward electronic payment generally, which itself is only one component—although one of the most crucial—in the development of e-commerce trends sweeping the globe. This section identifies and discusses the three most important and relevant payment technologies and their business models. The trio comprises: (i) the credit and debit card industry which forms part of a wider smartcard eco-system; (ii) the mobile phone-enabled super app payment systems, which have underpinned the rapid development of e-commerce in China, and which are poised to lead payment developments globally; and (iii) the mobile money phenomenon, which developed out of the M-Pesa system in Kenya and is particularly important in Africa.

CHAPTER 4

PROVIDES A BROAD CONCEPTUAL FRAMEWORK AGAINST WHICH TO EXAMINE THE CASE STUDIES

The shifts in fare collection embody a number of different changes which, although often related, need to be untangled to get a better understanding of developments.

This chapter identifies three overarching perspectives or dimensions through which the discussion of the trends can be framed. The first perspective is a technological one, which focuses on the emergence of new technologies that are enabling new ways of conducting business, such as the mobile phone. The second is an organizational perspective. While technological and organizational change tend to be partners in any innovation, they each need to be understood separately; too often a focus on the one is at the expense of missing key elements of the other. The third perspective is the mainstreaming of paratransit in Africa. While this could be viewed as a subset of organizational change, this third perspective is such an important pivot for policy makers in Africa, given the scale and growth of the paratransit sector, that it warrants being identified separately.

CHAPTER 5

SUMMARIZES THE CASE STUDIES

The full reports of each case study are long and detailed. This report has sought to identify concepts and trends and draw conclusions rather than convey the detail of the individual cases. The full case studies are available separately, including a more comprehensive summary than that contained here.

CHAPTER 6

IDENTIFIES KEY COMMON TRENDS EVIDENT AMONG THE CASE STUDIES

In the case studies the individual case is the focus; here, the analytical focus is on the wider trends.

CHAPTER 7

DRAWS CONCLUSIONS AND IDENTIFIES KEY TAKEAWAYS

This report should enable practitioners to more easily navigate the landscape in which they find themselves by merely identifying and explaining key trends in a systematic way. However, this chapter attempts to go further by drawing some conclusions and summarizing key takeaways.

2.

DEFINITIONS, CONCEPTS AND DEVELOPMENTS IN FARE SYSTEMS

The first part of this chapter clarifies the difference between fare systems in their totality and fare payment systems. Fare payment is only one of the three broad functions of a complete fare system—the others being the calculation of the fare and control over access to the transport service. The characterization is intended to help draw a distinction between innovation in payment technologies generally and payment-related innovation within the business processes specific to public transport. The second part of the chapter explains some of the main ways in which fare systems work, identifying and clarifying some key concepts.

2.1 // Distinguishing fare systems from fare payment systems

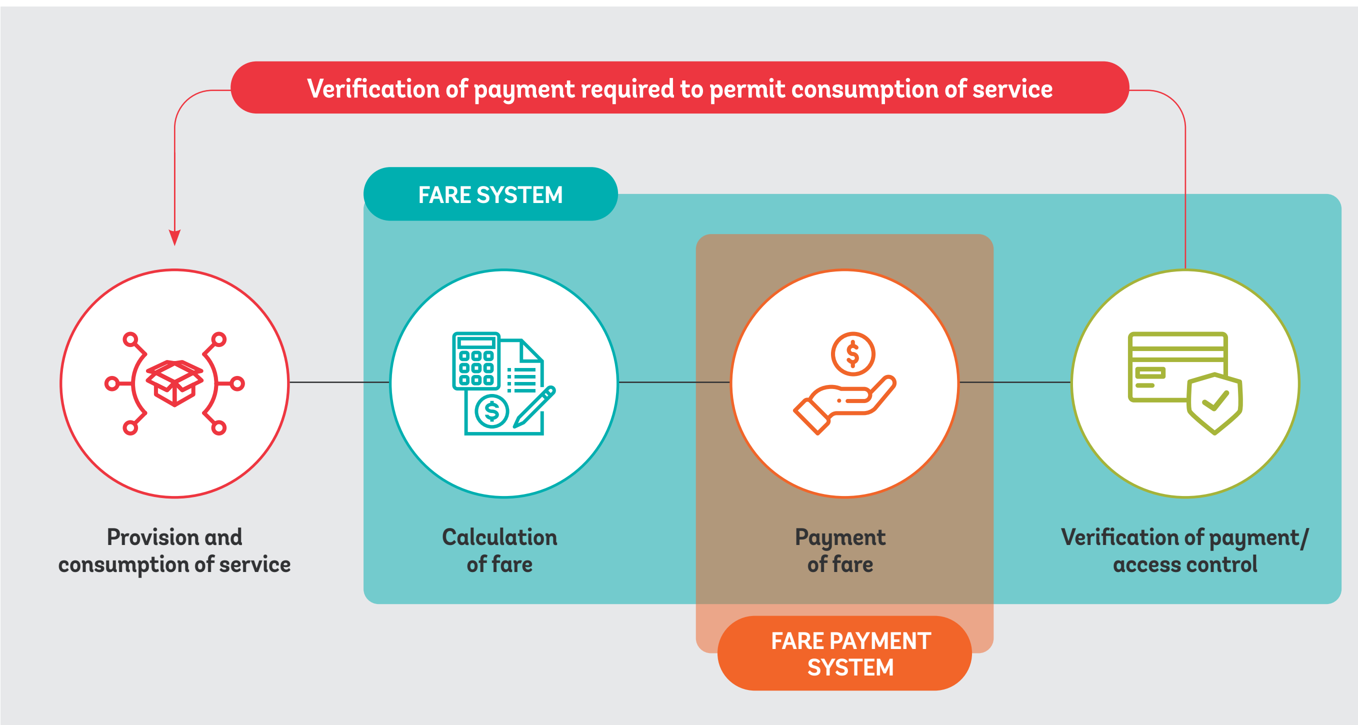
THE THREE BROAD FUNCTIONS OF A FARE SYSTEM

The three broad functions of a fare system are:

» Calculation of the fare payable
» Payment of the fare
» Access control based on verification of payment

Figure 2-1 illustrates these three components, distinguishing between the fare payment system and the wider fare system.

// **Figure 2-1**
Distinction between Fare System and Fare Payment System



Logically, the amount paid for the fare depends on first calculating the fare, with access to the service based on a payment having been made. However, the functions do not necessarily occur in this sequence.

For example, in a smartcard-based fare system a payment is made when the card is first loaded. Where the fare is calculated based on tapping in at the start of the journey and tapping out at the end, access has to be allowed before the actual fare is calculated. Access is allowed based on a set of system rules that assure that the card is valid and that it has sufficient credit to enable the fare to be deducted once it is calculated. While the user may pay to load the card prior to use, if there is a separate organization responsible for the fare payment component, the transport service provider may only receive the payment well after the journey is completed.

In a fare system these components work in combination with one another, often in complex ways. The fare payment system itself may be highly complex, with different elements of one component occurring at different points in the business process; for example, payment by the customer to load the card and payment reaching the service provider.

FARE PAYMENT

Payment can be made in many different ways. Before more sophisticated mechanisms were introduced, payment was simply by notes and coins or possibly with a token purchased with notes and coins.

In recent decades, credit and debit cards have dominated payment in the retail sector, while the transport sector has seen the widespread introduction of smartcards. In the last decade, there has been an explosion of payment technologies, such as the replacement of cards at the point of sale with mobile phones, mobile money, QR codes, and other forms of virtual payment. These new systems are increasingly entering the public transport market as mechanisms for making payments.

The fare payment component of the fare system involves loading a device with money or transport credit as well as deducing value based on the calculated fare, often by tapping the card at an electronic reader or validator. It also includes the process whereby the money is paid to the service provider. In some cases this can occur when the device is initially loaded. However, with the involvement of additional external agents, the service provider's receipt of payment can sometimes occur well after the service has been provided.

CALCULATION OF THE FARE PAYABLE

Fare calculation varies in complexity, the simplest being a flat fare. However, fares are often based on distance, and sometimes also on the time of day, such as peak and off-peak fares. They may be calculated using zones, based not only on distance, but also on whether the journey crosses specified boundaries. They can also differ, among other things, according to frequency of travel, mode of travel, and the age or other characteristics of the user.

In some cases the cost of the fare may be influenced by travel history; for example, fares may be capped once a daily travel limit is reached, in which case the amount charged bears no relationship to the normal price of the trip. Fares may be tapered or discounted for trips exceeding a certain number in a given time period; for instance, the first 40 trips in a month are charged a standard rate, the next 20 trips a discounted rate, the following 20 trips get further discounted, and so on.

In some fare systems, the fare calculation process is automated and performed by digital mechanisms that track the journey or set of journeys. In others, it is calculated by a person, such as when one buys a ticket or boards a bus or taxi and states where one wants to go. Typically, for example, a user boarding a *matatu* in Nairobi will be told by the driver or conductor—or the fare may be written on the vehicle—how much to pay based on the intended journey, and then the user pays the required amount using M-Pesa.

In automated fare systems the calculation of the fare is often a much more complex function than the payment component.

ACCESS CONTROL BASED ON VERIFICATION OF PAYMENT

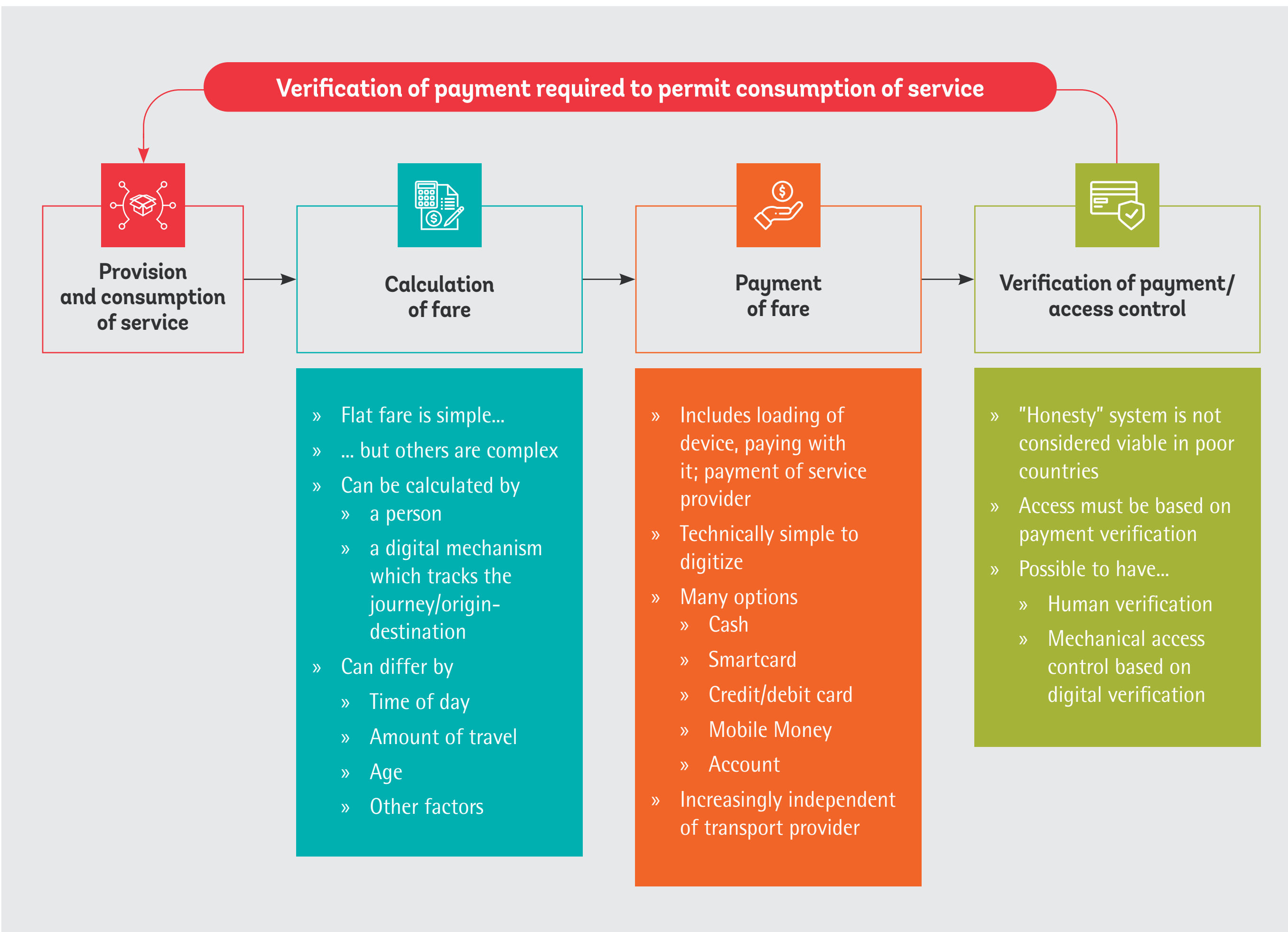
In the simple case of the *matatu* user, the conductor can see whether payment has been made and allow or disallow access. Some transport systems are based on honesty, with occasional checks conducted by officials who issue fines to users not in possession of a valid ticket; unless checks are comprehensive, such deterrents tend not to work in poorer countries.

Many automated fare systems have automated access control, where tapping a card or other device at an access point activates the gates and enables fare calculation. A sound may be emitted to indicate whether access is allowed or not.

ILLUSTRATION OF THE THREE FARE SYSTEM COMPONENTS

Figure 2-2 illustrates these different components.

// **Figure 2-2**
The dimensions of the three main fare system components.



2.2 // Some important types of electronic fare systems

CLOSED- AND OPEN-LOOP SYSTEMS

The use of automated electronic fare systems for public transport has grown rapidly since around the turn of the century, mostly using smartcards. Among the most famous have been the Oyster card in London, Hong Kong's Octopus card, Stockholm's Access card, and the Navigo card in Paris.

Originally, these smartcards were mostly designed as closed-loop systems. Technically, this means that feedback is given to the device providing information to the system. Thus, in a closed-loop system, when a smartcard or similar device is tapped at a reader, the system writes back to the card and alters the information on the card.

This can be more intuitively understood to mean that the fare system is closed to the wider world of electronic transactions. The card will need to be loaded from the wider world by purchasing transport credit which, although measurable in monetary terms, is no longer money, but rather a digitized credit that can be used on the closed system alone. Typically, the smartcard is loaded using cash, a credit or debit card, bank terminal or some other means. When the card is tapped at the terminal, the system is able to read the transport credit on the card. It then deducts the credit on the card, altering the information stored on the card.

A transport card of this kind can only be used on the system for which it was designed or on other systems that have been specifically engineered for business and technical interoperability. A closed-loop system can only be used with cards designed for it.

In contrast, in an open-loop system, no information is fed back to the card that was tapped; information is merely read off the card. This greatly expands the potential devices that can be used on the system. One of the best known open-loop systems is the mechanism whereby ordinary credit or debit cards can be used to pay fares for Transport for London (TfL) services. When a bank's credit or debit card is tapped at an entry terminal on the TfL network, the terminal identifies that it is a credit or debit card along with the unique number of the card. When the card is again tapped on exit, the system maps the journey that has been undertaken. The system back office adds up all the journeys undertaken by that credit or debit card during the day, and at the end of the day calculates a charge based on the lowest-priced travel package for that collection of journeys. It then charges the fare overnight to the credit or debit card account at the relevant bank via the credit or debit card payment infrastructure.

In this open-loop system no information is written back to the card by the TfL system; the card is merely used to identify a credit or debit card account, and at the end of the day the card company is charged the calculated fare.

There are various agreements with banks to avoid TfL incurring losses in cases of nonpayment. Furthermore, if payment is not settled at the end of the day, the card is blocked for future entry until the debt is honored.

Open-loop systems are very rare in Africa. The Gautrain in South Africa's industrial heartland has open- loop functionality similar to the TfL system, and this approach is being planned in some of the case studies examined.

Closed-loop systems can be expanded beyond the transport function alone. For example, the Oyster card can be used to buy coffee at particular shops, especially those located near the transport system. But this is only because these shops have signed up to the system and have terminals that can read and write to the Oyster cards.

Closed-loop systems require a system-specific card or a similar device to be loaded with value; open-loop systems create the possibility of using general payment mechanisms, such as credit or debit cards or mobile phones, directly on the transport system.

BACK OFFICE-CENTRIC AND CARD-CENTRIC SYSTEMS

In a back office-centric system most of the relevant information is held in the back office, and most of the fare calculations are performed there too. The card is mainly an identifier that allows the system to calculate the journey that has been undertaken; although in many cases it will also hold a record of the credit that is deducted once the journey or set of journeys is completed.

If the credit is held on the card and the system writes information back on the card it is a closed-loop system. It is possible, in other words, to have a closed-loop, back office-centric system.

In a card-centric system, most of the relevant information is held on the card. Such a card might hold information on special packages that have been bought; and when the card is used to enter the system it would hold information about the place and time of entry. When the card is tapped off the system, the boarding information, alighting information, and information about credit on the card is used in conjunction with the card reader to calculate the amount owed and deduct it from the card.

The advantage of a back office-centric system is that the readers and cards can be simpler, with much of the heavy lifting of calculating and charging fares being done using more powerful back office technology. Using these systems, changes in fare structures, for example, are very easy to implement.

However, back office systems are much more dependent on very good high-speed communications between the reader and the back office. If that communication happens to be broken at the moment when a user exits the system and the card is tapped off, it will be impossible to calculate the payment and deduct the credit at that point. Such systems need additional mechanisms, often referred to as redundancies, to address these risks and ensure that payment is ultimately correctly deducted.

One of the motivations given for 5G technology is that it speeds up communication between devices and the network.

BACK OFFICE AND CLOUD COMPUTING

Cloud computing has seen strong growth in the last decade. In essence, data processing is externalized from the specific location of the fare system back office into the cloud, supported by a network of computing capacity provided by the cloud service provider. In some instances, this can mean that communication between the card being tapped and the processing of data can be quicker and more secure, but this depends on the relative technical capacities and connectivity of the cloud as opposed to the back office. The way the two fare systems work is not fundamentally different, although general technical issues about how the cloud works, security concerns and regulation may impact the feasibility of moving a back office to cloud technology.

ACCOUNT-BASED SYSTEMS

Card-centric smartcard systems work anonymously, even if the card is registered in a particular person's name. In essence, the system is designed to allow the card itself to travel through the system so long as sufficient credit is loaded on it.

In an account-based system the individual has an account held in the back-office, and the device such as the card, is merely a token that is used by the system to record the movements of the person. The back office uses these signals to calculate and deduct the fare from the account held in the back office. Conceptually, the account holder is charged rather than the card. In most such cases, the account can be loaded independently of the card.

Uber and similar ride-hailing applications are also examples of account-based systems. In these cases the mobile phone holds the application that enables credit to be deducted from the account held in the system back-office. This is also what makes it possible for the account holder to pay remotely for a ride for somebody else.

Transport for London's open-loop system whereby credit cards are charged is sometimes referred to as an account-based system in that the back office generates data against the credit card ID which is used to tap on and off the system. In essence, the TfL back office holds an account for the day against the card ID, with the movements of the card used to calculate the fare amount payable, which is then charged at close of day to the bank supporting the credit card.

However, TfL does not hold any information about the card holder, and while records are obviously kept, the account is closed at the end of each day. In this sense, it is a different from the full-blown, account-based systems where an account is held on a sustained basis against an individual's identity and loaded and deducted from over time. Indeed, by some definitions the TfL system for charging credit cards would not be regarded as account based.

Account-based systems offer the possibility of holding other information about the account holder; this has its advantages, such as being able to direct subsidies on a targeted basis. On the other hand, in full account-based systems there can be challenges in ensuring the identity and details of the account holder are correct and that travel is recorded against the right account.

2.3 // Standards and fare payment systems in public transport

In any discussion on technologies such as fare payment systems, the concept of standards must be understood. Standards represent a common way of doing something.

The wide variety of appearances and functionalities of different fare systems may have many similar, underlying standards. For example, smartcards are standardized in many aspects, such as their physical dimensions, how they communicate with reading devices - different for contact and contactless systems - and the data exchange protocols used. Reading devices themselves might not have standards, although safety and electrical standards may be applicable, but the physical elements such as the connectors and data exchange protocols adopt certain standards. The data model would also be standardized, so that devices and back-end systems can understand the information that is exchanged across devices.

The International Standards Organisation (ISO) is the primary international standards organization. The ISO was established in 1947 and has a membership of 164 national standards bodies, one per country. International standards are developed through a lengthy but extremely thorough process involving participating national standards bodies and the relevant industry sector(s). A defined process exists for identifying the need for new or updated standards, developing the standards, and achieving consensus on adopting them.

A technology standard serves four main purposes. It:

» Enables connectivity and interoperability across different devices from different manufacturers.
» Codifies and incorporates good practices and efficiencies.
» Provides recognized test methodologies, which can be used for certification.
» Provides a trusted benchmark for quality.

Vendors are free to implement whatever technology they wish, subject perhaps to safety standards, but if they do not comply with relevant standards, it will be difficult or impossible for their devices to connect to, or exchange information with, devices from other vendors. Purchasers become locked in to that vendor. This may be acceptable to some purchasers, but it severely constrains them if they wish to do anything more than a limited in-house operation; and it is contrary to best practice. Similarly, vendors who do not use standards will usually find they have a limited potential market and are unlikely to be accepted by most public and corporate purchasers.

Standards are critical where different participants in a system work together; but there is a difference between interoperability and integration. Interoperability is the technical capacity of devices and systems to connect, work together, and share data, which is especially relevant when the devices or systems of multiple operators and vendors are involved. This is the natural domain of standards.

Whether they actually work together is a separate issue requiring agreements among relevant operators, system owners, service providers, and vendors. Integration relates to the organizational and business models that determine whether, for example, different public transport services will function as a network with a common ticketing scheme or common pricing. This is not the natural domain of standards; however, integration will inevitably require standards-based interoperability. Interoperability is, thus, a necessary but insufficient condition for integration in domains involving intelligent transport systems (ITS) and fare payment systems. Standards are merely enablers.

The functionality of a system will dictate what standards are relevant. Banking systems, for example, have a rigorous and comprehensive set of standards aimed at ensuring reliability and combatting fraud. Thus, a fare system that is integrated closely with banking systems will have to meet banking industry standards unlike other fare systems. Depending on the nature of integration, this may create rigidities and add to the expenses.


BRT - BUS STATION
POSTA
STRABAG
STRABAG

3. PAYMENT SYSTEMS

Ultimately, fares need to be paid for by passengers using generally accepted currency. In electronic fare systems, this element of the transaction forms part of the much wider phenomenon of electronic payment systems in general, which is currently one of the largest and most dynamic industries globally.

Developments in public transport fare systems are strongly influenced by the wider payment industry. For example, the development of closed-loop, smartcard payment systems for public transport grew as part of wider advances in card-based technologies.

This chapter focuses first on card-based payment, which was driven primarily by the credit card industry, and subsequently extended into debit cards and prepaid cards. It then examines the rise of mobile phone-based transactions, concentrating on China, a leader in this phenomenon. Finally, it describes the phenomenon of mobile money, which was developed in Kenya with the creation of M-Pesa, and which, interestingly, preceded the Chinese developments. Mobile money, which was developed independently of the banking system, is particularly strong in Africa where there is a relatively low level of banking service; it is, therefore, of particular importance to this study. The chapter ends with a brief section on the regulation of payment transactions.

The growth of payments using mobile phones in China is significant for two reasons. First, Chinese mobile phone-enabled transactions fully substitute the credit card payment infrastructure—sometimes referred to as payment rails—rather than merely provide a convenient portal to the credit card system, which is the normal practice in countries of the Organisation for Economic Co-operation and Development (OECD). Second, the Chinese phenomenon has led to what is sometimes referred to as the super app business model, which many are trying to emulate globally.

The potential earnings from being the favored mechanism for making electronic payments are vast. Fees are not necessarily earned from facilitating the payment transaction, as has been shown by key Chinese Internet companies, but rather from being able to access and use the individual, consumer level information generated by the transaction to sell a wide range of goods and services.

The competition to become the favored mechanism for electronic payments is now intense, driving technological innovation and broadening offerings. It is felt in the transport sector, where payment mechanisms are not only proliferating, but the industry is also experiencing or will soon experience both the opportunities and pressures arising from being one of the more significant terrains on which this competition is being fought.

3.1 // Card payments

CREDIT CARDS

i) Origins

Modern payment cards were initially issued by retail merchants. In 1950, a number of merchants consolidated their individual cards into the Diners Club,[1] making it possible to pay many merchants with a common card, with accounts all settled through a consolidated bill at the end of the month.[2]

Bank of America launched the BankAmericard in 1958, the first, significant revolving credit system with a card issued by a third-party bank, that is a bank independent of the merchant or the consumer. The card was eventually licensed to other banks, which from 1976, united their individual cards under an association with the common brand name, Visa®. Mastercard® originated in 1966 with a group of banks establishing what was initially called MasterCharge. Citibank joined this group in 1969. Barclaycard was launched in the UK in 1966. Mastercard® and Visa® dominate the market internationally.

The key challenge in launching the credit card system involved having enough card holders so that merchants were incentivized to support the system, and sufficient merchants supporting the system to make it of benefit to card holders. Bank of America addressed this by mailing cards to thousands of residents in a town in California where they dominated banking. This practice was repeated by other aspirant-issuing banks, and it is estimated that by 1970 when laws were changed to allow only application forms to be mailed unsolicited, approximately 100 million credit cards had been dropped into the U.S. population.[3]

This history is important since it illustrates the challenge of getting a foothold in the payments market. A widely used public transport payment system could potentially offer one mechanism, among others, for a payments company to get a foothold in the market.

ii) Business model

Apart from convenience, the credit card business model is driven by the way in which credit is provided to consumers, paid for by the merchant selling the goods or services.

When a customer buys goods with a credit card, usually within a day, the merchant is paid—through the credit card system—the price of the goods minus a transaction charge amounting to between one and five percent of the price. The key component of this transaction charge is known as the interchange fee. It is explained as the cost of the interest the merchant would have had to bear had the customer only paid after receipt of a monthly account, plus a grace period. The benefit to the merchants is that they receive their money immediately, even though they have to bear the cost of extending credit to the customer until payment would have been due. Access to credit also stimulates sales, especially of big-ticket items.

The credit card user does not bear any costs directly, although ultimately, consumers in general pay for the credit since merchants incorporate these costs into their prices. In agreements with card companies, merchants accepting credit card payments are generally not permitted to pass the charges on to the credit card user specifically. Thus, in general, the consumer rather than the credit card user, in specific, is paying for the cost of the credit.

The card holder has to pay the bank which issued him or her the card at the end of a designated grace period, usually of 21 to 25 days after the end of the billing cycle, with high interest rates payable by the card holder after this cut-off date.

The system is driven by both convenience and an extension of credit to the customer where he or she does not have to bear the interest costs directly.

iii) Mechanics of credit card payments

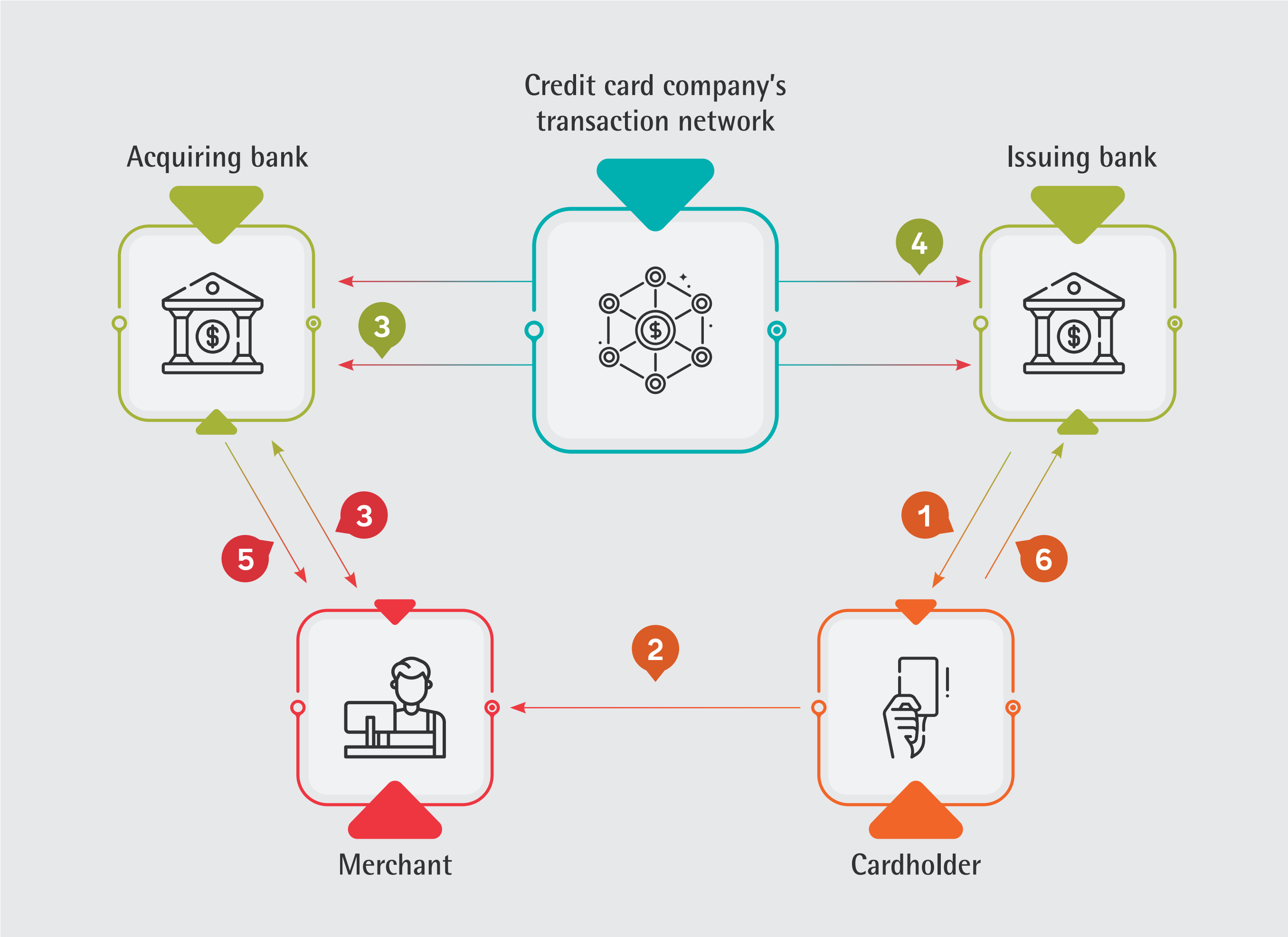
Initially when using a credit card, the merchant would have to call their own bank by telephone, which then called the credit card company to check the customer's balance. From 1973, this process began to be automated, over the years substantially reducing transaction time.

Credit card payment approval and settlement is now very fast, and functions across national boundaries. The infrastructure networks and systems[4] through which payments are made and settled are massive and need to be highly secure and robust. Many ostensibly independent payment mechanisms are, in essence, gateways that make use of the infrastructure networks and systems of the major credit card companies.

The terminology used for credit card systems is used in the description of many payment systems. Thus, it is useful to explain the key parties involved in credit card systems (Table 3-1).[5]

// **Table 3-1**
Key parties involved in credit card systems.

Cardholder	The consumer using the card to make purchases
Card-issuing bank (also known as the issuer)	The financial institution or other organization that issues the credit card to the cardholder. This bank bills the consumer for repayment and bears the risk that the card is used fraudulently. Many banks around the world use the various major brands such as Mastercard® and Visa®, benefitting from their extensive infrastructure and sophisticated systems.
Merchant	The business accepting payment by credit card for goods and services sold.
Acquiring bank (also known as the acquirer)	The financial institution that accepts payment for the goods or services on behalf of the merchant.
Independent sales organization	Re-sellers (to merchants) of the services of the acquiring bank. Banks sometimes use independent sales organizations as their agent for managing relationships with many smaller businesses.
Merchant account	The merchant's account at the acquiring bank.
Card association	An association of card-issuing banks such Visa® or Mastercard®, that set transaction terms for merchants, card-issuing banks, and acquiring banks.
Transaction network	The system that implements the mechanics of the electronic transactions.
Affinity partner	Some companies or institutions lend their names to a card issuer to attract customers that have a strong relationship with that company or institution, and get paid a fee or a percentage of the balance for each card issued using their name.



// **Figure 3-1**
Mechanics of credit card transactions.

The process for paying with credit cards is as follows:

1. The issuing bank issues a credit card to the customer or cardholder. The cardholder now has a credit card account with the issuing bank.
2. The cardholder presents the card to the merchant to pay for goods or services supplied.
3. The merchant uses a point of sale (POS) device usually provided by the merchant's own bank, the acquiring bank. The card is inserted or tapped at the device, sending a message to the acquiring bank, which transmits the information relating to the amount and other characteristics of the sale via the credit card company's network to the issuing bank. Usually this requires the cardholder to punch in a personal identification number (PIN) that has been programmed into the card to ensure that it cannot be used by anyone other than the cardholder. The issuing bank verifies that the cardholder is sufficiently within his credit limit and issues an authorization and approval code, while reserving the amount against the cardholder's limit. The merchant receives the approval code.
4. The authorizations, which are sent in batches between acquiring and issuing banks, are cleared and settled at the end of the business day through the credit card association, with the issuing bank then paying the acquiring bank. Sometimes this process takes more than a day; and sometimes a merchant gets an authorization but only submits it for settlement a few days later.[6] The process of clearing and settling often involves the central bank.
5. The acquiring bank pays the merchant, usually making the payment into a merchant account held at the acquiring bank.
6. The cardholder pays his credit card account at the issuing bank within about three weeks of the end of the billing cycle.

iv) Credit card fees

As indicated, the merchant incurs the fees for the cost of processing the transactions; these consist of the interchange fee and a further set of services fees, sometimes referred to as a discount rate, an add-on rate or "passthru".[7] The total fee incurred by the merchant on credit card transactions is usually between one and five percent of the price of the transaction.

The interchange fee is viewed largely as compensation for the interest incurred by the issuing bank on the credit extended to the cardholder to bridge the period between payment to the merchant and repayment by the cardholder. It is therefore paid to the issuing bank, and generally accounts for between 70 and 90 percent of the total fees payable.

Service fees are paid to the acquiring bank and the credit card company or association. Service fees are structured in many different ways. For example, where merchants rent their POS device, the costs may be recovered separately or folded into the service charge.

The credit card association is the main body determining the fee structures, especially the interchange fee. Interchange fees have a complex pricing structure, based on issues such as the card brand, regions or jurisdictions, the type of credit or debit card, the type and size of the accepting merchant, and the type of transaction, for example online, in-store, phone order, and whether the card is present for the transaction.

Further complicating the rate schedules, interchange fees are typically a flat fee plus a percentage of the total purchase price and taxes. In the United States, the fee averages approximately two percent of transaction value. In the EU, interchange fees are capped at 0.3 percent of the transaction for credit cards and to 0.2 percent for debit cards.

Note that for cash withdrawals using a bankcard, the interchange fee is paid by the issuing bank to the acquiring bank for the cost of maintaining the ATM, and then passed on to the cardholder as a withdrawal fee.

Fees are a critical issue when using credit or debit cards to pay for small purchases. Where fees are structured around a minimum flat fee amount, using a credit or debit card to pay for small items such as public transport fares can result in a very high proportion of the price flowing to the card company.

v) Prepaid credit cards

Many people would like to use a credit card because of its convenience, but do not qualify for credit from banks. With a prepaid credit card, the cardholder pays an amount equal to the credit card limit ahead of using the card. Transactions are debited against this amount. This system is useful for some international travellers where accounts can be loaded with the currency of the country in which the card is to be used. However, it is a somewhat expensive way of paying with your own money.

DEBIT CARDS

Debit cards developed on the back of the technological advances in automation made by the credit card industry. They are similar to credit cards, but the money is transferred immediately from the cardholder's bank account when a payment is made. They function similar to a check book system, and have largely replaced checkbooks. Some debit cards carry a stored value on the card, while in others a message must be relayed to the cardholder's bank.

Since debit cards developed essentially to replace checks, they developed on a country-specific basis, building on national bank clearing and settlement systems previously supporting check payments. Only after 2000 were there agreements to enable debit cards issued in one country to be used for purchases in others. While big card companies such as American Express®, Mastercard® and Visa® all offer debit cards that are accepted globally, many debit cards are accepted only within a particular country or group of countries. Some of these are now branded under more widely recognized brands, such as Maestro®, which is part of Mastercard®.

Debit cards are usually processed by electronic funds transfer at point of sale (EFTPOS)—also known as online debit or PIN debit—but sometimes use the electronic purse card system. Online systems, which are the most common, require electronic authorization every time a transaction is made, and these transactions are reflected immediately in the user's bank account.

In electronic purse systems, value is stored on a chip embedded in the card so machines accepting these cards require no real time network connectivity. In these systems, the deduction in credit is written back to the card, so the POS device and card need to be part of the same system. These systems have been used widely since the 1990s and are similar in concept to closed-loop public transport systems; although unlike most transport smartcards, they only have the capacity to make payments rather than also calculate the fare payable.

Offline debit cards, where the user signs at the POS, similar to older credit cards, present greater risk to the merchant and are decreasing in use.

PREPAID DEBIT CARDS

Debit cards are usually issued in association with bank accounts. However, prepaid debit cards are sometimes issued, especially to unbanked people. The key advantage of a prepaid debit card is that it removes the requirement for carrying cash. In high crime environments, this advantage is most significant not for the debit card user but for merchants, who do not then need to keep large amounts of cash in tills, which can be robbed. The transporting of cash is also reduced. A prepaid card is generally used with a personal identification number (PIN) so an unauthorized person without access to the PIN cannot use the card.

In some countries it is possible to deposit paychecks and government benefits onto such cards.

Generally, the identification requirements for prepaid card users are lower than for those with a bank account. This makes prepaid debit cards useful for people whom banks will not or may not serve, such as nonresidents of a country. To the extent prepaid debit card systems start adding more services, such as accepting payment from more sources, or allowing card to card transfers, they become more like simple bank accounts.

CLEARING AND SETTLING

Payment between issuing and acquiring banks involves the process of clearing and settling. This is usually done once a day, and generally involves the national central bank.[8] Clearing is the process of sorting and verifying all the many individual transactions and netting them out to determine the amount each bank owes other banks. Settling is the process of making the payment. Usually this is done by adjusting the accounts held by each bank at the central bank.

A number of countries are developing new systems to ease the system of settling individual accounts between banks. One of the most advanced is India. It has combined a system of national identity numbers—called 'Aadhaar'—where every person[9] has a unique 12 figure ID number linked to digital fingerprints and an iris scan, with a unified payments interface (UPI). The National Payments Corporation of India, which is a nonprofit partnership between the central bank and 56 commercial lenders, manages this UPI. UPI began operating in 2016, and since 2018, has leapt ahead of all other mechanisms for settling payments in India, such as the credit and debit card systems. Compared with the US system, Fedwire, it is much cheaper, and unlike Fedwire, settles in real time, operating 24 hours a day.[10]

UPI is interoperable, designed to allow individuals to manage money residing in several accounts from a single bank or payment service app on their phone. It is also designed to allow fintech or big-tech interfaces to work through its infrastructure. An example is WhatsApp, which is piloting an interface that will support payments and inter-account transfer services to more than 400 million Indians.[11]

Other monetary areas, such as the Eurozone, are developing somewhat equivalent systems aimed at instant settlement. Europe's TARGET Instant Payment Settlement (TIPS) was launched in late 2018 and enables individuals and firms across the Eurozone to transfer money between each other within seconds, irrespective of the opening hours of their local bank.[12]

3.2 // Payments by mobile phone

Mobile phones are increasingly being used to make payments through varied ways. The earliest large-scale use of mobile phones to make payments was in Africa, with mobile money such as M-Pesa being transferred like SMS's using old feature phones. However, globally, new forms of payment by mobile phone have now far outstripped this type of mobile money. These include the vast Chinese systems Alipay and WeChat Pay, as well as Apple Pay and Google Pay, previously Android Pay. Mobile payment is also growing rapidly in South-East Asia and India.

ALIPAY AND WECHAT PAY[13]

i) Scale and growth of the Chinese mobile payment companies

Alibaba and Tencent are the two huge Chinese Internet companies which pioneered and now dominate digital payments in China, and are among the largest payment companies in the world. The value of mobile payments in China increased dramatically between 2014 and 2018, and is estimated to reach US$19.9 trillion in 2021,[14] with 92 percent of the Chinese mobile payments market accounted for by the payment arms of Alibaba and Tencent—Alipay with 53 percent and WeChat Pay with 39 percent.[15] China has an estimated 890 million unique mobile payment users, and it is anticipated that the number of these users making payments to merchants will rise from 577 million in 2019 to approximately 700 million in 2022.[16]

Digital payments have become so dominant that the People's Bank of China has had to forbid merchants from refusing to accept cash. Meanwhile, the use of credit and debit cards is even less than cash. It has been reported that some beggars have even replaced tin cups with QR codes.[17] As part of the shift to digital payment dominance, the central bank, The People's Bank of China, is piloting virtual currency.[18]

As an indication of the scale of these Chinese mobile payment companies' value, it was estimated that Ant Financial, Alibaba's sister company that owns Alipay, was 50 percent larger than Goldman Sachs, and had overtaken long established US financial firms such as Mastercard®, HSBC and Citigroup by 2018.[19] Measuring all payments—not just mobile payments—Alipay processed more than US$17 trillion in the financial year ending in June 2020, while Visa® processed US$8.8 trillion in the year ending September 2019.[20]

ii) Origins and development

A critical feature of Chinese mobile payment companies is that they were not developed by the financial sector but grew out of the activities of e-commerce companies selling goods and services online, similar to Amazon.

Alipay grew out of the online commercial site Alibaba. Its popularity expanded especially as a result of it providing an escrow system. Payments made by the customer can be held in an escrow account and are only released to the merchant once the goods are satisfactorily received. One of the obstacles to establishing the practice of online purchases was that Chinese consumers feared that after paying the seller they may not actually receive the goods. The escrow account mechanism significantly increased trust in using the system.

WeChat Pay developed originally as a mechanism for paying for Tencent's online gaming offerings, but was boosted enormously through the company's mobile message system, WeChat, which developed an associated mechanism for mobile payment. Facebook, through its WhatsApp application is now seeking to emulate the Tencent model.

iii) The super app business model

Both Alibaba and Tencent now each have a whole ecosystem of goods and services that are sold online, with Alipay and WeChat Pay infrastructure and systems used as the payment rails, sometimes referred to as the super app business model. Under this model, the main motivation behind the payment systems is not to make money from the financial transactions themselves, but to hold the cost of financial transactions low, and develop the platform for a much larger market of online commerce.

This model provides the e-commerce companies with an enormous wealth of data on each individual user that can be leveraged to increase sales.

One of the next steps for these companies is to become involved in retail sector logistics, disrupting traditional models of how goods flow from producers to consumers. This development has obvious relevance for the transport sector.

The super app model tends to be the dominant model that most payment companies are now pursuing worldwide, with clearly massive incumbency advantages. Two significant vehicles for expanding the popularity of super apps in the personal transport sector have been in ride-hailing and food delivery services.

Although the penetration of banking services in China was deep, slow and inefficient bank services facilitated the rise of these mobile payment mechanisms. Moreover, the credit card companies such as Mastercard® and Visa® were not permitted to operate. This meant that the Chinese companies were able to become the dominant technology companies supporting payments between banks. Indeed, Ant Financial refers to itself as a "techfin" company rather than a "fintech" company.[21]

Despite its primary objective not being to profit from online payments, the mobile payment business has provided a pathway into financial services. By enabling users to invest money held in mobile wallets into the money market, for example, Ant Financial now runs the largest money market fund in the world.[22] Both Ant Financial and Tencent have developed a diversified range of financial offerings.

By comparison, Amazon developed making use of the payment rails of the credit card companies such as Visa® and Mastercard®, and has thus not developed the kind of mobile payment and financial services capabilities that the Chinese companies have. Both Alibaba and Tencent are aggressively pursuing international opportunities.

iv) QR codes

Quick Response (QR) codes have been key to the rise of Chinese mobile payments. Initially, Alipay and WeChat Pay developed as a mechanism to facilitate online payments between users' bank accounts. However, the use of QR codes has enabled the spread of mobile payments to purchases from merchants at the point of sale.

In essence, the card payment system uses the merchant's POS device into which the card is inserted or tapped, and which then communicates online with the banking system to effect the payment. With mobile phone payments, it is the customer's phone which is online, and all that is required is a printed QR code. The mobile phone's camera reads the code to get the information required to make the payment into the merchant's account. The merchant then simply needs a mobile phone to monitor by SMS that the payment has been made into his account.

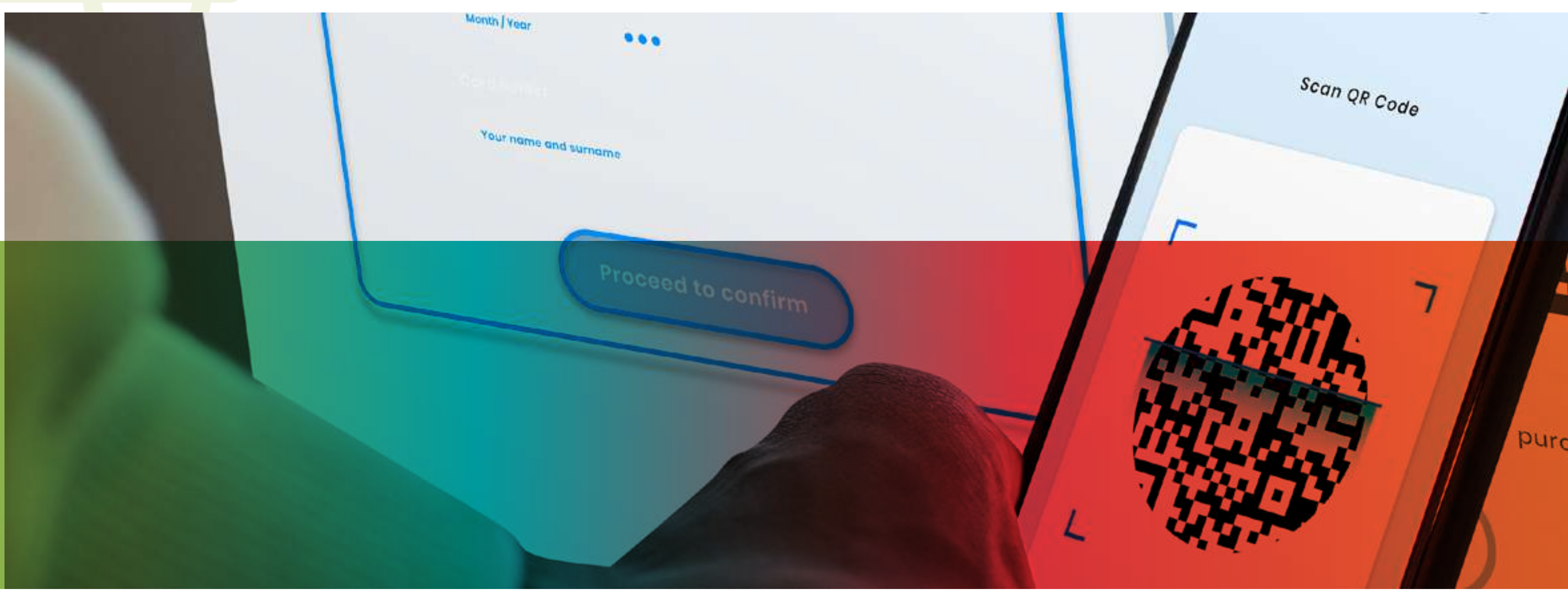
Merchants bear limited costs in accepting mobile payments in this way, yet have the convenience and security of knowing the money has been deposited into their account.

APPLE PAY AND GOOGLE PAY

Apple Pay and Google Pay (previously Android Pay) are growing in use and popularity, especially in the US. However, they are in essence—like many mobile payment systems—just a mobile portal into the more traditional payment systems. In these mobile payment systems, the user loads a card onto the application (app). The app then either loads a localized digital wallet and pays from that, or securely codes the card in a manner that is readable by the merchant's device.

The mobile phone camera's facility to read QR codes to effect payments is also becoming more widespread, obviating the need for a merchant to have a POS device.

These systems seek to develop the features of a super app and capitalize on the data that can be collected through the monitoring of transactions made. However, the two companies do not combine this with a major payments infrastructure in the manner of Alipay and WeChat Pay.



3.3 // M-Pesa and the mobile money phenomenon

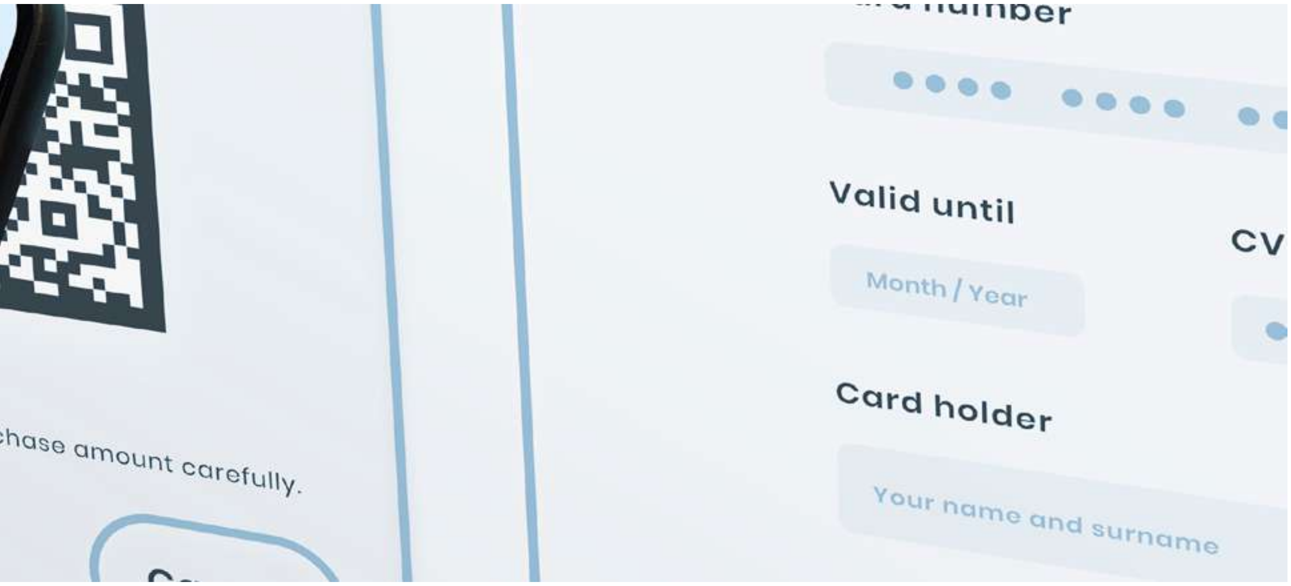
WHAT IS MOBILE MONEY?

Mobile money is not itself an official fiat currency, but an alternative currency created by the mobile network for transferring value across the network, and having a one-to-one exchange rate with the official currency. Mobile money often seems to have the same characteristics as ordinary money, but transferring money across the mobile network requires an on-ramp and an off-ramp. At the on-ramp official fiat money is used to purchase mobile money. This can be sent across the network to a recipient who must exchange it once again at an off-ramp to convert it back into official currency.

The merit of the system is that it was able to grow without the same kinds of security and integration requirements with the banking system demanded when actual currency is transferred. However, as mobile money systems have progressed, and more recipients accept it as a means of payment, it has become increasingly like an ordinary currency. Indeed, because all transactions in mobile money are recorded electronically, it is recognized as offering better security than traditional transactions and a key mechanism for countering corruption. For this reason, many official payments in Kenya made by and to the government use M-Pesa, and a large proportion of Kenya's GDP is now transacted in this mobile currency. Regulation has advanced in support of the system.

In many of the case studies analyzed in this report, mobile money is used to pay directly for public transport trips or to load smartcards for use on public transport systems.

In most low-income countries with poor banking infrastructure, the path to financial inclusion is primarily through mobile money.

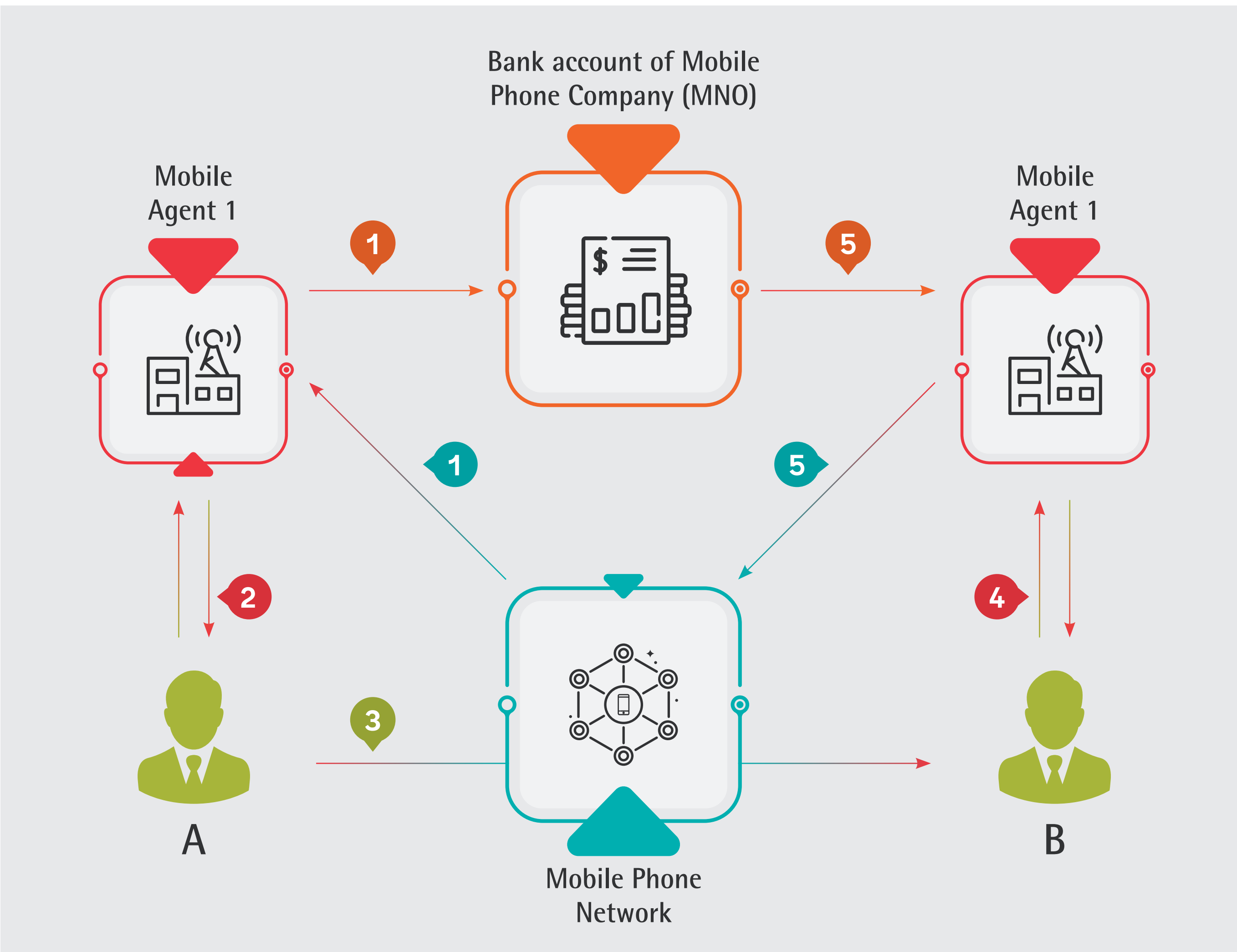


THE MOBILE MONEY TRANSACTION PROCESS

Payment by mobile money follows the process illustrated (Figure 3-2).

1. The mobile phone company sells mobile money credit in bulk to a mobile agent, who is often a small retailer generally also selling airtime to mobile users. The credit is a form of mobile money voucher. The mobile agent pays the mobile phone company for this mobile money, depositing cash into the bank account of the mobile phone company.
2. Person A goes to local Mobile agent 1 and buys mobile money from the agent receiving electronic mobile money credit on their phone for the cash paid. The agent charges a small fee for this transaction, referred to as on-ramping; Person A has now changed money into what might be described as a mobile money voucher that can be used on the mobile money network.
3. Person A sends mobile money across the mobile network to Person B, who may be close by or could living geographically far from Person A.
4. Person B takes the mobile money voucher to the local Mobile agent 2 and exchanges it for cash. This is referred to as off-ramping.
5. Mobile agent 2 sells the mobile money vouchers back to the mobile phone company and receives cash in return.

// **Figure 3-2**
The mobile money transaction process.



If a number of people wish to send money in opposite directions then the mobile agent need not exchange the mobile money for cash at the mobile company's bank, but can sell it on to another person instead, earning a fee for the service.

Once sufficient numbers begin using mobile money and are confident of always being able to turn it back into actual cash, people will tend to transact in mobile money instead of actual cash. Thus, mobile money can effectively become a parallel currency with a one-to-one exchange rate with the fiat currency, yet more convenient and secure to use than the fiat currency because it can easily be sent between mobile phones.

Critical to this system is having agents where money can be on-ramped and off-ramped, and a secure network that protects mobile money users from fraud or loss. Agents are paid a transaction fee, and the mobile phone company usually, although not always, charges a small fee for transactions. The fee structure is designed to optimize returns to the mobile phone company, and high fees will discourage use of the system. The fee for on- and off-ramping is generally always higher than the fee for sending mobile money over the network.

Any mobile money vouchers which a mobile phone company sells into the system have to be backed by cash in the mobile phone company's bank. If people are able to create mobile money fraudulently, then the mobile phone company would have to honor the voucher when presented; therefore, mobile phone companies must ensure their systems are secure.

Because users often do not cash in their mobile money, the mobile phone company could be tempted to create money that is not backed by cash. However, financial regulation is aimed at preventing this.

ORIGINS AND RATIONALE

The first significant instance of mobile money was M-Pesa, which was launched by the main Kenyan mobile network operator (MNO), Safaricom, in 2007, the year before Alipay launched its first mobile wallet in China.

Originally attempting to develop a local micro-financing system, M-Pesa was developed by Safaricom in association with its key shareholder, Vodaphone. Those piloting the scheme came to realize that rather than micro-financing, the main activity for which participants were using the scheme was to send money home.[23] The M-Pesa money transfer system was born out of this, building on the technology and practices for sending airtime between phone users that had been launched in 2005. In an environment with very low bank penetration, the system was able to rapidly play a vital role in transferring money between mobile phone users, often in rural areas, using the agent network that had developed across the country to sell airtime as the on- and off-ramps.

GROWTH AND PREVAILING INITIATIVES[24]

The use of mobile money has grown remarkably, reaching more than a billion registered mobile money accounts in 2019.[25] Figures for 2019 published in 2020 show that 372 million of those accounts were active, with 290 mobile money services running in 95 different countries. Seventy-seven of the mobile money services had in excess of a million customers with active accounts over a 90-day period. Globally, the number of agent outlets has almost tripled since 2015, and it is estimated that the reach of a mobile money agent is now seven times that of ATMs and 20 times that of bank branches. In the five years to 2019, the number of active mobile money agents per 100,000 adults tripled to 228, while the figure for commercial banks in the same markets stagnated at 11 per 100,000 adults.

The industry processes in excess of US$1.9 billion daily, and in 2019, the value of digital transactions within the system exceeded the value of cash-in and cash-out transactions. The system is, thus, increasingly developing well beyond being used only as a means to make person-to-person transfers.

Tables 3-2 and 3-3 show the geographic spread of mobile money by region and by each of the subregions within Sub-Saharan Africa, respectively.

// **Table 3-2**
Mobile money industry size in 2019 and percentage growth over the previous 12 months by global region.

Region	Live services	Registered Accounts	Active Accounts	Transaction Volume	Transaction Value (US$)
East Asia and Pacific	52	158 mil	60 mil	4.4 bil	78.9 bil
		23.8%	29.4%	52.9%	41.5%
Europe and Central Asia	9	20 mil	7 mil	217 mil	3.8 bil
		7.3%	20.5%	31.0%	26.8%
Latin America and Caribbean	27	26 mil	13 mil	601 mil	16.5 bil
		2.5%	-1.6%	-24.2%	1.4%
Middle East and North Africa	21	51 mil	19 mil	663 mil	9.1 bil
		3.6%	3.5%	24.0%	37.4%
South Asia	37	315 mil	91 mil	7.3 bil	125.4 bil
		3.9%	6.0%	19.6%	16.3%
Sub-Saharan Africa	144	469 mil	181 mil	23.8 bil	456.3 bil
		11.9%	15.3%	19.7%	27.5%
Global	290	1.04 bil	372 mil	37.1 bil	690.1 bil
		10.2%	13.6%	21.8%	26.0%

// **Table 3-3**
Mobile money industry size in 2019 and percentage growth over the previous 12 months by subregions of Sub-Saharan Africa

Region	Live services	Registered Accounts	Active Accounts	Transaction Volume	Transaction Value (US$)
Eastern Africa	54	249 mil	102 mil	17.1 bil	293.4 bil
		9.9%	10.6%	15.1%	24.0%
Central Africa	17	48 mil	20 mil	1.8 bil	30.4 bil
		14.1%	23.9%	49.6%	32.7%
Southern Africa	14	9 mil	3 mil	165 mil	2.5 bil
		13.8%	17.8%	18.6%	21.8%
Western Africa	59	163 mil	56 mil	4.8 bil	130.0 bil
		14.5%	21.5%	28.4%	34.9%

As is evident from the figures, Sub-Saharan Africa represents by far the biggest market for mobile money services globally, accounting for US$456.3 billion out of a global total of US$690.1 billion in 2019. Eastern Africa, which includes Kenya, Tanzania, Ethiopia and Mozambique among others, accounts for 53 percent of registered mobile money accounts and 64.3 percent of the value of transactions in the Sub-Saharan Africa region.

Western Africa also contributes a sizeable portion of the Sub-Saharan African market with 35 percent of all accounts and 28.5 percent of transactions value. Central Africa (10 percent of accounts and 6.7 percent of value) and southern Africa (2 percent of accounts and 0.5 percent of value) are considerably smaller. The low level of usage in southern Africa stems largely from the fact that the banking system in these countries, especially in South Africa, is well developed and the regulatory framework has not easily supported mobile money transactions. However, this may be changing, with MTN, the large South African mobile network operator, putting significant resources into mobile money efforts across its markets, mainly in Africa.

While the size per region differs, all regions have grown strongly across all measures over the past 12 months, with central Africa showing the biggest rise, although off a small base, and western Africa second. Africa was not the only region to grow strongly, with particularly strong growth in East Asia and the Pacific—23.8 percent rise in registered accounts and 41.5 percent rise in transactions value.

Nigeria, with the largest population on the continent and an unbanked population representing 60 percent of the country, has seen rapid growth in innovative financial services over the last 24 months. This is partly as a result of regulatory easing leading to the establishment of payment service banks—that support a variety of transactions but may not issue credit or make international payments—some of which are subsidiaries of local mobile operators, and growth in smartphone penetration from 12 to 40 percent in five years. MTN Nigeria, one of the biggest MNOs on the continent, began offering mobile money transfers in August 2019 after being given a super-agent license. With its wide reach and strong agent base it is in a powerful position to rapidly scale up mobile money services in Nigeria.

INDUSTRY DIRECTION

A number of key developments in the mobile money industry are of relevance to this study of innovative fare systems in Africa.

First, consistent with the Chinese super app business model, MNO's are paying significant attention to broadening the payments service by linking the mobile money payment facility to a widening range of commercial uses and markets, including paying for public transport. The industry refers to this as payments-as-a-platform, described in the GMSA Annual report (GMSA 2020) as a "strategic shift by the industry to encourage more value to remain digital and to diversify revenue models by unlocking more targeted services for individuals, businesses and communities." The shift in this direction was reflected in the 2019 figures by a significant drop in reliance on customer fees and rising revenue from business fees.

Second, mobile money service providers are developing and publishing application program interfaces (APIs) to facilitate this. APIs are a set of specifications that independent parties must match to engage digitally with the service. This makes it much easier for third party providers to develop apps that link to the mobile money system to make or receive payments. Uncommon until recently, 20 percent of respondents to a GMSA mobile money survey reported in 2019 that they have published APIs.

On average, mobile money service providers are integrated with 98 billers, including 17 government agencies, 11 utility companies, 52 organizations for bulk disbursements, and more than 13 thousand merchants.[26] Payments for utility services, such as energy and water, account for 44 percent of the value of all bill payments processed via mobile money services globally. This practice is particularly strong in Sub-Saharan Africa and South Asia, where utility payments account for 53 percent and 55 percent of the total value of bill payments processed via mobile money.

The MTN Group opened its API program for its mobile money service (MoMo) in seven countries in 2019, with 3700 developers having registered in the program within the year to create interfaces with the system.

Third, interoperability between banks and mobile money services is growing rapidly, as well as between the accounts of different service providers. Links to banks not only eases the process of on- and off-ramping from cash to digital, but connects users to a range of financial services. Interoperability also eases international remittances as the industry becomes more integrated with players in the international financial system. Links between mobile money service providers means that mobile money transfers can be made between participating mobile network operators.

Fourth, while unstructured supplementary service data (USSD)[27] is the most common interface used by mobile money providers globally, the trend to use QR codes, while small, is growing. As has been shown in China, the QR code is very convenient for the merchant, and in the case of a mobile money service, it eliminates the need for customers to manually enter the merchant's number. A GMSA survey indicates that merchants who use QR codes transacted three times more in value than those who only offered other channels (GMSA 2020). Early evidence suggests that, as in China, the use of QR codes has the potential to support profound and lasting behavior change, making digital payments the payment mechanism of choice.

SMART PHONE PENETRATION

While the penetration of smartphones in Africa is rapid, most smartphones are expensive. However, the cost of smartphones is falling as new operating systems compete with established players and established companies are forced to drop prices in response. For example, a relatively new, low cost Linux-based operating system called KaiOS[28] is growing rapidly in some poorer regions, with entry-level phones in India in 2020 retailing at US$11 and sophisticated models at around US$40.[29] Unlike traditional feature phones which act as a simple communication tool with the mobile network, the sophisticated operating system on the phones themselves enables them to run on 3G and 4G, the more recent generations of mobile technology, giving users access to the Internet, and supporting a significant number of the most commonly-used apps, such as WhatsApp, Maps, YouTube and Facebook. They have cameras that enable QR codes to be scanned, and they allow users to make data calls, avoiding high voice costs. Crucially, they facilitate a range of payment and other financial services not easily performed using USSD. Innovations such as these are an important reason why established companies are increasingly having to offer low cost options too.

THE SUPER APP MODEL AS A DRIVER OF CHANGE

Developments in India are an example of the speed and scale of change as various forces position themselves to replicate the super app model in context-specific ways. Jio, the Indian mobile telecommunications and digital services operator owned by Reliance, has grown massively over the last four years, signing on 388 million people by early 2020 to its low cost internet services using KaiOS phones, among others, while investing US$40 billion in a 4G network in India.[30] Facebook agreed to pay US$5.7 billion for a 10 percent stake in Jio in early 2020, its biggest investment after its US$19 billion purchase of WhatsApp in 2014. Google invested US$4.5 billion in Jio for a 7.7 percent stake in July 2020.[31] Working with Jio, WhatsApp received permission in November 2020 to launch payment services—referred to as WhatsApp Payment—in India[32,33] and launched the service in December 2020. The service has been designed on the National Payments Corporation of India's (NPCI) unified payment interface (UPI) system, and integrates with all the major banks. Within a few years, Jio has advanced from nowhere to dominate the Indian telecommunications sector, based not on providing person-to-person communication, but by positioning itself to be an e-commerce super app in the Indian market, working with Facebook and Google, and replicating Tencent's WeChat Pay model of building a payments system onto a messaging system.[34,35]

It seems likely that mass-market, low-cost phones will support a strong, new wave of mobile internet transactions, including payments and other financial services in Africa and elsewhere, driven by mobile network operators seeking to become the platform for the equivalent of the Chinese super apps.[36] Mobile money in Africa may yet offer the payment mechanism provided by Alipay and WeChat Pay in China and WhatsApp in India.

Integrating fare payment into such a model would be one likely objective of such initiatives.

3.4 // Regulation

The dominance of the credit card industry in OECD countries has meant that the scope for innovation has been more limited there than in developing countries such as China and India, as well as the Africa and South-East Asia regions. Low penetration of the banking system was a key contributing factor to Africa being the first region of the world to start using mobile phones to transfer money.

These differences in circumstance become reflected in regulation, which then often turns into a key factor itself influencing development and innovation.

Financial services have always been a key area of regulation. The value of a currency depends on the trust that people have in it. Meanwhile, banking systems—where, for instance, banks are permitted to issue loans many times the value of the reserves they are required to hold—require tight regulation to manage systemic risk. Loss of trust in a national payments system can have serious, substantial, and adverse impacts; and it may only take a few incidents among a limited number of players for this distrust to become systemic.

At the same time, countries such as China and India have seen the scope and value of being able to develop their own national payments systems, and have thus regulated the entry of foreign players into their financial systems. Had Visa® and Mastercard® been able to operate freely in China, the indigenous industry may not have developed.[37] While India's radical demonetization project has boosted digital payments overall, its regulation of foreign companies is fundamental to how such companies engage.

But regulation also often lags behind technological developments, with the result that it can become inappropriate—missing real risks while overregulating where it is unnecessary. Furthermore, regulations are usually developed through cooperation between the central bank, the national government and the key incumbent financial sector players. This group of actors can have a tendency to resist new developments by which they may feel threatened.

The key areas that are subject to regulation in the public transport fare systems, and more widely, payments systems include:

» Security of transactions to ensure that payments are truly reflected without any fraud or leakage.
» Requirements under certain circumstances to know-your-customer (KYC) combined with the security of personal data to counter inappropriate use.
» Control over the creation of money.

The latter becomes relevant where a system starts holding users' credit at scale. Payment systems have to retain reserves equal to the credit that is stored on them; otherwise they take on the features of a bank, with an ability to create money.

The cases researched in this study are all subject to regulation, and the way in which regulation influences the development of payment mechanisms is crucial.

Notes

1. The Diners card is now more akin to a credit card.
2. Wikipedia https://en.wikipedia.org/wiki/Credit_card - accessed 20200420
3. https://en.wikipedia.org/wiki/Credit_card
4. Banknet in the case of Mastercard and VisaNet in the case of Visa
5. Table constructed from information at https://en.wikipedia.org/wiki/Credit_card
6. For example, when a hotel gets an authorization at the start of a stay, but only submits it for clearing at the end of a stay.
7. https://en.wikipedia.org/wiki/Interchange_fee
8. Central banks are not always involved. For example, the Swish card system in Sweden is cleared and settled privately among banks, although participating banks retain a deposit as a type of insurance with the central bank.
9. Introduced a decade ago, it now has 1.2 billion people on the system
10. Financial Times 16 Dec 2019 'India's payments revolution'.
11. Ibid.
12. https://www.ecb.europa.eu/paym/target/tips/html/index.en.html
13. This section draws from various sources, including CGAP (September 2019) China: A Digital Payments Revolution; and Aaron Klein (April 2020) China's DigitalPayments Revolution https://www.brookings.edu/wp-content/uploads/2020/04/FP_20200427_china_digital_payments_klein.pdf
14. Financial Times 4 August 2020 'China's new digital currency takes aim at Alibaba and Tencent' quoting Beijing-based iResearch.
15. Aaron Klein (April 2020) p4; note that in the Financial Times 4 August 2020 article 'China's new digital currency takes aim at Alibaba and Tencent' Beijing-based iResearch is reported as estimating Alipay's share of the market at 55.4% in the first quarter of 2020.
16. CGAP (September 2019) p.1.
17. Aaron Klein (April 2020) p.1
18. Guardian 28 April 2020 'China starts major trial of state-run digital currency'
19. Financial Times 13 April 2018 'China's Ant Financial shows cashless is king'
20. Financial Times 25 August 2020 'Ant Group reveals $2.6bn profit as it files for blockbuster IPO'
21. Financial Times, 16 Jan 2020: 'Ant Financial turns to banks to revive plans for huge Asian IPO'
22. The fund is called 'Yu'e Bao', which means "leftover treasure".
23. https://www.howwemadeitinafrica.com/father-m-pesa-innovative-africa/56456/
24. Most of this section draws from statistics and other material found in the annual 'State of the Industry Report on Mobile Money' for 2018 and 2019 published by the Association of the Global System for Mobile Communications or GMSA in 2019 and 2020 respectively
25. GSMA (2020) State of the Industry Report on Mobile Money 2019.
26. Ibid.

27. USSD stands for 'Unstructured Supplementary Service Data'. USSD messages are up to 182 alphanumeric characters long. Unlike Short Message Service (SMS) messages, USSD messages create a real-time connection during a USSD session. The connection remains open, allowing a two-way exchange of a sequence of data. This makes USSD more responsive than services that use SMS.
28. Built by Kai OS Technologies, a US-based company.
29. https://telecomtalk.info/jiophone2-top5-features-it-worthy-4g-feature-phone-rs2999/180768/ accessed 13 May 2020.
30. Financial Times 18 May, 2020 – 'Ambani's ambition to turn Reliance into internet titan wins backing'
31. Financial Times 15 July 202 – 'Google to pour $4.5 billion into Reliance's digital business'. The investment by Google may herald an attempt to produce much cheaper Android phones to compete with the KaiOs phones.
32. Financial Times 6 November 2020 – 'WhatsApp gets green light to launch payments service in India'
33. Financial Times 23 April 2020 – 'Facebook and Jio deal creates huge lake of Indian data'
34. By contrast, the death of 20 Indian soldiers in a brutal clash with Chinese troops on the Himalayan border in June 2020 has resulted in a wave of anti-Chinese sentiment that has proven disastrous for Chinese fintech investments in India at a critical moment in the development of the industry
35. In August 2020 Reliance paid $3.4bn for the retail assets of India's second biggest network of 'bricks and mortar' retail stores, Future Group. Combined with the retail assets they already controlled, Reliance now controls approximately a third of all bricks and mortar stores in India, combining its emerging on-line retail dominance with its powerful traditional retail position - Financial Times 31 August 2020 'Reliance to pay $3.4bn for India's second-largest retailer Future Group'
36. In 2020 Reliance launched its e-commerce platform, JioMart, challenging Amazon and Walmart owned Flipkart, the two biggest e-commerce platforms in India.
37. It is likely that China will soon open their systems to these foreign entities, but they are unlikely to be able to compete with the now established indigenous companies.

Reference

GSMA. 2020. State of the Industry Report on Mobile Money 2019; GSM Association. https://www.gsma.com/sotir/wp-content/uploads/2020/03/GSMA-State-of-the-Industry-Report-on-Mobile-Money-2019-Full-Report.pdf

4.

FRAMING THE ANALYSIS OF THE CASE STUDIES

In examining emerging innovations in fare payment systems in Africa, being overly focused on new technologies can cause other important dimensions to be missed. Technology is often what makes the most impact, but new ways of doing things usually combine technology with organizational and business process change. These can often entail significant shifts in the respective roles of stakeholders in a business, altering power relations and benefitting some more than others. Understanding this is particularly important when seeking to implement policies or projects aimed at modernizing fare systems.

This study has examined the chosen cases from three key perspectives explained in this chapter.

4.1 // Three perspectives for assessing fare systems

The first perspective for assessing fare systems is a technological one. The sections below highlight some key characteristics of technologies that are now well established globally, as well as new technologies built mainly around the rise in mobile phone usage, which are more contemporary. The second perspective highlights organizational and institutional issues in the management of fare systems. The third is about the mainstreaming of paratransit, which while arguably a form of organizational change, has been identified as a discrete dimension of change because of its importance as a critical issue in public transport discourse in Africa.

In some cases, only one of the perspectives is of interest for understanding a particular phenomenon, while in other cases, all three perspectives are relevant (Figure 4-1).

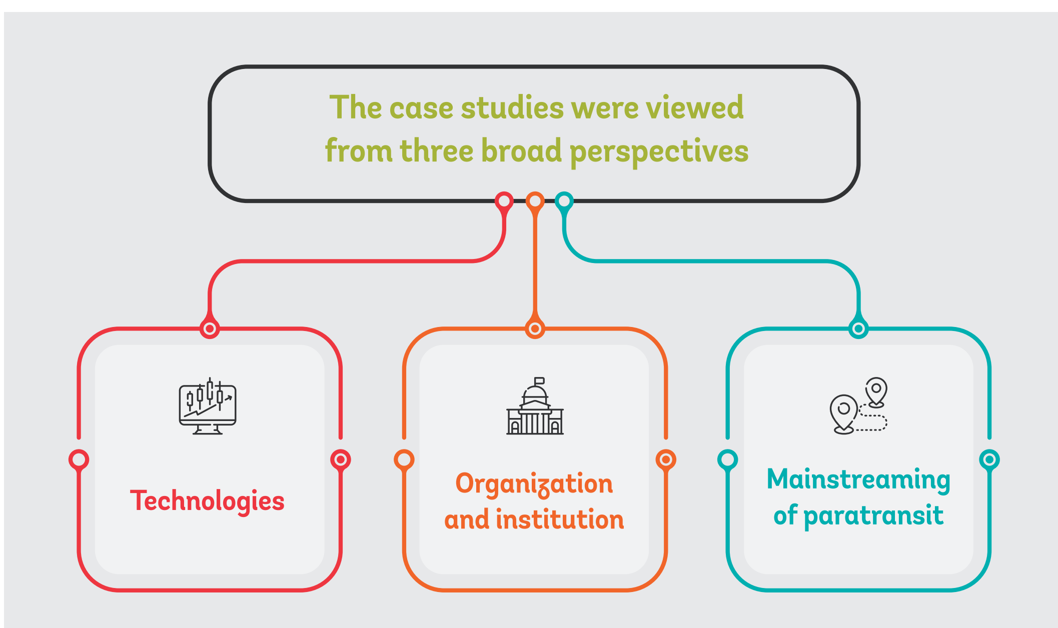


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Figure 4-1
Three overarching perspectives that frame the emerging trends in fare systems in Africa.

4.2 // Technologies

The technologies discussed here have mostly been identified in earlier chapters. They are discussed in more detail here, sometimes referencing the case studies.

CARD BASED FARE SYSTEMS

i) Enabler of electronic fare systems

Card-based fare systems are not new technologies; they have been in existence for approximately two decades. However, in a number of African cities, the shift away from cash to electronic payment is taking the form of card-based fare systems, sometimes with innovations such as being able to load using mobile money.

Globally, smartcards were the key technology that enabled the shift from manual fare systems based on cash and paper tickets to electronic, automated fare systems. These introduced a significant advance in efficiencies. Transactions could be much quicker and more transparent for those managing the system, while reducing the scope for malfeasance. Furthermore, they offered an enormous advance by greatly improving the available information on ridership patterns, which could be used to enhance overall system efficiency.

The introduction of smartcards include the developments highlighted in the case studies of Cape Town, Kigali, Lagos and Maputo. Nairobi is illustrative of failed attempts to introduce card-based systems and a gravitation toward systems using mobile phones, driven in particular by the popularity of M-Pesa.

Users often do not have phones that are suitable for the envisaged fare system or are reluctant to use phones for transactions. Kigali's system is card based, but mobile phones can be used to generate a ticket that can be scanned into the reader to ride the system. Similarly, Chalo—a private company we examined in our case studies operating in a number of cities in India — provides for both technologies as well as for cash payment.

ii) Calculating the fare

It is important to distinguish between fare systems and fare payment. Fare systems calculate the fare and usually play some role in controlling access to the system.

Flat-fare systems are much simpler than systems where the fare differs on the basis of distance traveled. A system where a flat fare is charged per route—but where the fare is different for different routes—introduces a rudimentary form of variation by distance, while still allowing the electronic reader on each vehicle to be set to deduct a constant amount. In implementing a new system, the fare structure may have to be revised to accommodate the capabilities of the new technology.

Distance-based systems of any sophistication require users to tap on entry and again on exit so that the distance can be calculated. This, in turn, requires a more sophisticated interchange of information between cards and readers, and the capacity either to calculate the fare as part of a local, card-centric transaction, or send information to a back office for it to be calculated there.

iii) Card centric or account based; closed or open

Technologies may be closed, card-centric systems or more open systems. Constraints on connectivity in African cities tend to require systems to be more card centric, although this is not always the case. The proposed new system in Maputo is largely account based and back office centric.

iv) National or local approach

Most of the cases examined in this study embody both national and local initiatives, and this issue is often of importance in the adoption of new systems in developing countries. The respective roles of national government and local stakeholders can significantly influence the nature of the technology used.

In some cases, national governments have sought to drive the introduction of a national transport card that can be used by all public transport systems. National governments have also seen the introduction of electronic fare systems as an opportunity to advance the introduction of cashless payments in the wider economy to help address threats of crime and corruption, and gain a better understanding of the nature and extent of transactions.

MOBILE PHONES

The most significant new technology influencing fare systems in Africa is the mobile phone. Within fare systems they represent a major development in technology as they enable substantial two-way communication between users and the system. This is in contrast to card systems, where communication is limited and essentially unidirectional. Although in a closed system, information is written back to the card, the key function of the card is to indicate to the system that the user is boarding or alighting.

Cards often require significant investment in loading infrastructure and, even so, are often quite difficult to load. They are dependent on a system of validators—which may be costly—to communicate between the card and the back office. A smartphone, however, can be used with a cheap, printed QR code to communicate with the system.

The mobile smartphone in combination with a back office and other connectivity is able to:

- Load a virtual card and thus function like a card within a card-based system.
- Generate an electronic ticket that can be read by a conductor or a QR code that can be read by a validator.
- Load credit conveniently from a mobile banking or equivalent app.
- Easily make a payment to a recipient having only a printed QR code.
- Be tracked at all times, if permitted, not just at tap-on and tap-off points.
- Offer system information, and trip and transfer choices to the user.
- Offer a booking service.
- Track and provide ETA for arriving vehicles and final destination.
- Provide information about how full the arriving buses are so that the user can decide whether to take the later bus.
- Integrate with face recognition or other systems for user identification.
- Send out trip requests if the service is demand responsive.
- Automatically generate information on driver behavior.
- Be used by a customer to rate service provider performance.

Uber was the first company to show how the mobile smartphone could revolutionize transport for individual riders through ride hailing, changing the way both supply and demand are organized while massively improving the ability to match supply efficiently with demand. In addition, Uber integrated this with a fare system that accurately calculates the fare and provides a simple and convenient way to pay.

The mobile smartphone has the ability to bring new efficiencies to public transport across the full spectrum of services, although these will differ among services (Figure 4-2). Among mass transport services with fixed routes, such as rail services, its usefulness revolves mainly around improving transfers and journey planning, whereas for more flexible and demand responsive services, it enables the development of new service offerings where supply responds to demand, potentially in real time. Across all services, the mobile smartphone offers a convenient mechanism to pay.

The case studies demonstrate that some of the potential functionality of the mobile phone is beginning to be realized in Africa. This entails not only using mobile phones to pay for services, usually with mobile money, but extends to improved matching of supply and demand, booking of services such as SWVL in Nairobi, and the use of QR codes as with GONA, a provider of mobile payments solutions for merchants and consumers in Lagos. As evident in the case studies, an important emerging innovation is the use of mobile phones to load smartcards.

OTHER TECHNOLOGICAL DEVELOPMENTS

No other significant technological developments threaten to disrupt fare systems in a major way. However, developments in improved connectivity, cloud computing, data collection, management and processing, and other technological areas all support the expansion of electronic fare systems.

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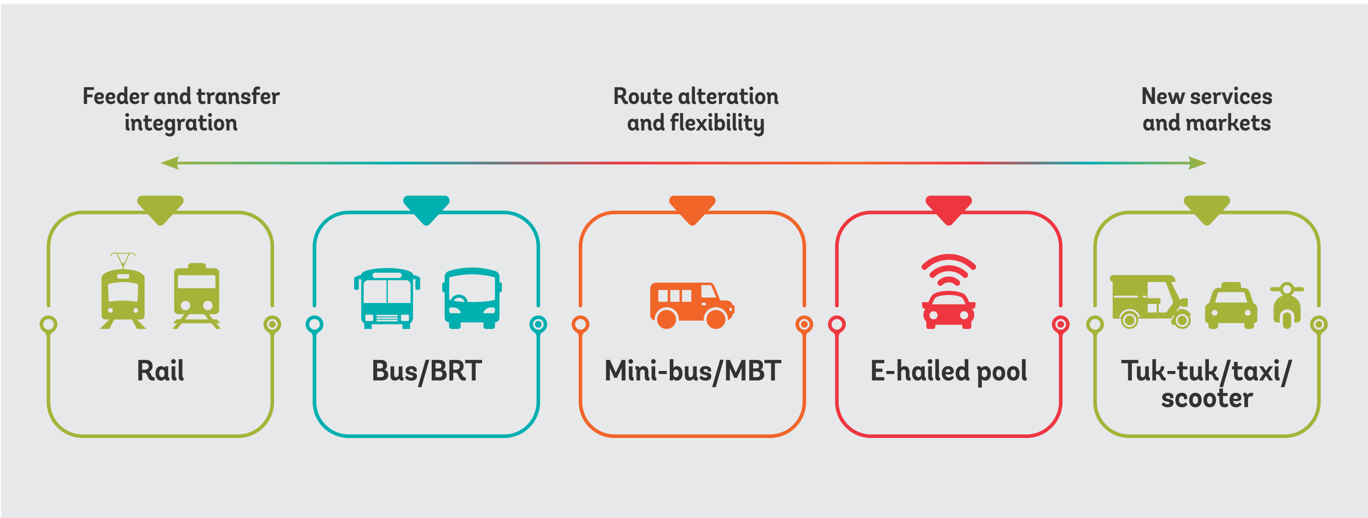
Figure 4-2
New technologies will affect different modes differently.



4.3 // Organizational and institutional issues

THE DRIVERS OF NEW ORGANIZATIONAL FORMS

The second perspective for assessing fare systems is an organizational one. New organizational forms for the management of fare systems are emerging, driven to a significant extent by a desire to implement new, efficiency-enhancing automated fare systems that bus operators themselves are not always best placed to do.

However, new organizational forms are also driven by a desire to improve overall transport system efficiency. All cities include a variety of public transport modes that often operate independently of one another in ways that reduce efficiencies. A widely-held objective among public authorities aiming to optimize public transport in a city is to achieve integrated public transport, where the different modes complement one another rather than compete. This has led to changes in the way public transport operations are regulated and contracted.

The introduction of new fare systems often co-exists with these changes to the institutional environment. While new fare systems are often perceived primarily as a move toward enhancing fare system efficiency and integrated ticketing enabling a single ticket to be used across all modes, they are often part of a much more fundamental change in the way revenue flows, and how risk—and power—are allocated.

ALLOCATION OF REVENUE RISK

A good way of understanding institutions entails examining how risk is configured and the incentives and power relations that flow from that.

Many public transport systems—and arguably all paratransit systems—are based on individual vehicle operators competing along a route. An association of operators may collectively control some aspects of competition among individual operators, yet the earnings of each operator are based on the number of passengers the vehicle carries. In other words, the operator assumes the revenue risk.

In paratransit systems, the risk usually goes a step further, with the driver absorbing much of the revenue risk. This is because many paratransit systems work on some form of a target system. The driver pays the owner a set amount for using the vehicle for the day or week, and pays for costs such as fuel, but then keeps all fare revenues. The more passengers the driver transports, the more he earns. Thus, the driver bears the revenue risk—often within a context of power relations where the target is exploitative of the driver.

This allocation of revenue risk creates incentives that determine driver behavior. For example, within the incentive structure, it is logical for drivers to race to be the first to pick up passengers and overload.

If individual drivers collectivize to pool revenues in some way, and no longer receive payment based on the number of passengers their own vehicle carries, the incentives change. Usually this entails the formation of a company-like structure, where vehicles are collectively owned, and drivers are paid a salary. The revenue risk would then shift to the owners of the company.

The bus company may receive a concession arrangement, where it is given permission to operate on a route or receive a subsidy to operate a route, perhaps in exchange for meeting certain minimum service standards and route frequencies. If the company keeps the fare revenue as part of its income, it is considered to operate on a net basis; the subsidy is net of the fares earned.

Destructive competition problems similar to those occurring among individual vehicles may arise between bus companies operating in more atomized systems. For instance, where more than one company operates on a net basis within the same market, companies will have an incentive to increase their revenue through ways that are not always in the interests of the user, such as cherry picking routes or timing arrivals at a stop just before their competition does.

In this context, there is once again a strong argument for pooling revenues and distributing them among the companies on a logical basis, according to the transport services provided, such as vehicle-kilometers. The individual bus companies receive their full payment from the collective fare pool, an arrangement referred to as gross contracting. Thus, the companies collectively take revenue risk and have an interest in cooperating with one another to maximize the total revenue earned from all their transport services combined.

Gross contracting arrangements could be run on a private basis, but often a public authority is involved. Sometimes the public authority or its agent merely arranges for the collection and distribution of the fares, with the private companies taking revenue risk collectively. However, sometimes the public sector agrees to pay the vehicle operators an agreed amount for services delivered irrespective of how much is collected in fares. In such cases, the public authority takes the revenue risk (Table 4-1).

There is not always a sharp distinction between each of these categories. For example, where the owner collects the fare and pays the driver a wage, but also offers the driver an incentive bonus if more income is collected, the owner and driver share the risk. Similarly, the formula for payment in many so-called gross contracts includes factors such as the number of passengers carried, thereby including net contract features. The continuum is represented by the arrow on the left of Table 4-1. Allocation of risk could lie anywhere along the continuum (Table 4-1).

Fare systems will need to align with these arrangements. It is thus evident that how fare systems are organized is not just a technology issue or a fare systems efficiency issue, but a fundamental element in the way institutions, incentives, and power relations in the delivery of public transport are constructed.

There is a danger that initiatives intended to modernize fare systems fail to pay sufficient attention to institutional dynamics. While this may simply reflect a lack of insight on the part of the promoters of new systems, it could also constitute a conscious agenda where a significant objective to advance institutional change is conveniently disguised within a modernization initiative.

Under different models the risk shifts from driver through owner to companies or public authority

Model	Description of arrangement	Who takes most revenue risk?
Public responsibility gross contracts	Public authority receives fare revenue and pays bus operating companies for services provided, taking responsibility for any fare revenue deficit against payments made	Public authority
Private responsibility gross contracts	Fare revenue from overall service is pooled and shared based on transport services provided amongst the companies who collectively provide the service	Bus companies collectively
Company net contracts or concession	Company owns fleet of vehicles, employs drivers on a wage basis, and keeps fare revenue – plus any available subsidy	Bus company shareholders
Vehicle owner with wage paid driver	Individual vehicle owner pays driver a wage and keeps fare revenue	Individual vehicle owner
Driver in "target system"	Driver pays vehicle owner for use of vehicle and keeps fare revenue	Driver

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Table 4-1
Changing allocations of fare revenue risk in different institutional models.

TIMING AND ROUTING OF PAYMENT TO OPERATOR

When an electronic fare payment system is introduced, the direct exchange of paying for a ticket and getting the service is often broken to some degree. Usually, money collected is initially placed in a bank account that may belong to an independent party responsible for fare collection rather than the operator.

Even where no shift in revenue risk exists, the changes resulting in automating the system and removing cash may have a significant impact on how accessible fare revenues are to certain parties; for example, a driver who used to have cash on hand to buy fuel, or even pay a bribe, may now be without.

With an automated fare system, the vehicle operator may receive payment at one of three key moments. First, payment may be received more or less when the service is rendered. This is the case, for example, on Transport for London services when paying by credit or debit card using the open, account-based option. In such cases, the funds take anywhere from 24 to 48 hours to actually pass into the account of the authority that receives the fares, but the receipt is more or less simultaneous with the provision of the service. This is generally the case with open systems since they allow general payment devices to be used on a transport system.

Second, as a result of introducing an automated fare system, payment may be received *before* the service is rendered—when value is loaded onto the fare payment device or account. This can only occur in a closed-system environment, where loading value onto the device or account constitutes a purchase of travel credit. It can be of significant benefit to the transport provider since it is usual for users to load the device or account at least some days before using the credit for travel. In some instances, users load their value long before they travel or do not travel at all. As of September 2019, £399 million had been loaded onto TfL Oyster cards and not used in the previous 12 months.[1]

Third, payment may be received at a moment unrelated to either loading the device or account or making the trip. This occurs when a contractual relationship exists between the entity responsible for fare collection and the service provider based on services rendered, independent of fare payment. Usually this would be the case when operating in a gross contracting environment, but could also hold in a net contracting environment on agreement that the independent fare collector pay at a predetermined time, such as the end of the week or month (Table 4-2).

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Table 4-2
Timing of bus company receipt of fare revenue under different arrangements.

Timing	Description
Revenue received when value is loaded	When value is purchased and loaded onto a smartcard or other devices for the purpose of travel, revenue is received from the passenger by the fare system prior to travel. This is norm with "closed" systems
Revenue received when journey is undertaken	Revenue may be received from the passenger when travel is actually undertaken. In automated fare systems this is usually the case with "open" systems
Revenue received independently of load or journey	Revenue may be received from the passenger either before or when the journey takes place but by contractual arrangement the vehicle operators may be paid by arrangements independent of this. This is often the case in gross contracting environments

The timing of payment can be a key factor in how benefits are distributed. Holding the float can be lucrative as illustrated by the TfL case. Vehicle operators may, however, be happy to forgo holding the float in exchange for regular, pre-agreed, predictable payments based on gross contracts.

ROLE OF THIRD PARTY FARE COLLECTORS

With the increased sophistication of fare systems, specialists who are independent of the bus operator are increasingly involved in fare collection, further adding an important dimension. All the case studies reflect this in some form. The implications differ according to whether the third party is a public authority or a private entity motivated by profit. In addition, outcomes are affected by the basis on which the third party is engaged. Is it merely acting as an agent for which it is paid a fee or does it bear revenue risk?

Ultimately, the critical issue is whether the benefits and savings generated by the automated fare system exceed the costs of implementation, maintenance and operation and who bears those costs.

i) Third party fare collection by private sector

Critical to understanding the role of the private sector in revenue collection is understanding its business model. At one end of the spectrum are the private firms that are contracted to perform specific services for a fee that is independent of the revenue collected or the number of transactions. At the other end of the spectrum are the fare collecting companies that operate on what might be termed a concession basis, with wide latitude as to how they function. Within these two alternatives are a range of different options.

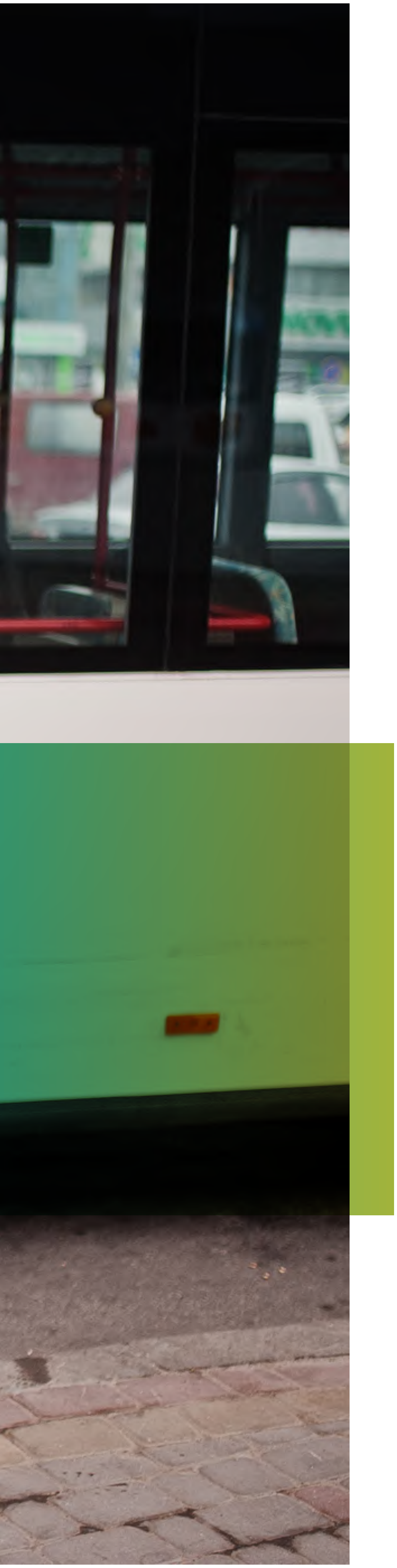
A common approach is to pay the fare collection company a portion of the fare collected. All fees could be paid in this way, with a possible alternative being a combination of an initial fee covering capital infrastructure with a relatively small proportion paid on an ongoing basis as a percentage of the fare or the number of transactions.

Many factors affect how, when, and how much benefit accrues for the independent fare collection company. The contract between the bus operators and the fare collection company will need to address how these are managed; one being the issue of clarifying when the collected fare revenue is paid over to the bus operator.

In pricing the service, the fare collecting company will need to assess different risks. To the extent the fee is based on turnover, accurately estimating ridership and fare levels are of critical importance, yet may be very uncertain. Inaccurate estimation could lead to anything from large windfall gains to bankruptcy; the contracting process will have to give careful attention to this.

A key reason for extending the analysis to Chalo, in India, is its business model. When entering into contracts with transport operators to provide fare collection services, Chalo's prevailing standard practice is to guarantee the operator a regular payment a little in excess of the average revenues historically received by them. Chalo then takes a share—which may be all—of the revenue collected in excess of the guaranteed minimum. This means that Chalo takes over the revenue risk and, from the perspective of the operator, transforms a net contract into a gross contract.

When third party fare collectors become involved, the relationship ought to be such that they share the revenue risk and, thus, have an incentive to improve ridership and service effectiveness overall. Charging a fee per transaction does share risk to some degree; however, Chalo's business model creates a much clearer alignment of risk exposure.



Chalo's business model naturally incentivizes it to use the information generated through fare collection and its other services to improve their service, thereby increasing ridership and profits.

ii) Third party fare collection by public sector

In some cases, the independent fare collecting agent may be a public sector body, although even in these cases, the public body will almost certainly contract out many of the tasks to the private sector.

Among the case studies, Cape Town's myconnect case is an example of a public authority, the City of Cape Town, running a fare system independently of the bus operators. It is a gross contracting model, where the bus operators are paid based on services provided, such as revenue kilometers driven, and the public authority ultimately bears most of the revenue risk. The City of Cape Town implements the system using specialist private companies, but it owns much of the equipment and pays the private companies a fee for work performed. The only revenue or transaction related fee is that paid to the banks for services such as the loading of cards or payment of fares.

This approach makes sense when multiple service providers operate on a gross contracting basis; however, it depends on having a competent public authority able to take charge of the fare system, and in Cape Town's case has resulted in high costs.

iii) Owning the customer

A critical issue where third party fare collectors are involved is what is sometimes referred to as owning the customer. Although the main experience of the service will always remain the actual trip undertaken, most communication is likely to take place between the customer and the fare system service provider. Apart from paying for the service, communication may include getting information on what services are available, journey planning, rating the service, and making complaints about poor services.

In these cases, the fare collector is responsible for much of the business-to-customer relationship, while the bus operator has a business-to-business relationship with the fare collector. While this offers benefits, it also presents challenges when things go wrong. Managing a three-party set of relationships requires well-designed business processes and accountability mechanisms.

E-commerce firms have exhibited great interest in developing multifunctional apps through which a variety of different goods and services are procured and paid for, with the Chinese super apps being the most dramatic examples.

Because transport is a widely used service, being responsible for the application through which public transport trips are paid for, and perhaps hailed or booked, offers significant potential benefits. The Kigali case study touches briefly on YegoMoto, which is extending its services from transport to the purchase and delivery of goods and services through its mobile app. This is likely to be a growing trend.

4.4 // Mainstreaming of paratransit

RECOGNIZING THE CONTRIBUTION OF PARATRANSIT

The third perspective from which it is useful to examine trends in fare collection is that of the mainstreaming of paratransit.

While significant financial resources and effort have been directed toward the formal public transport sector across Africa over the years, there is arguably not a single African city where the formal public transport sector carries a higher number of passengers than the informal paratransit sector. Even in Cape Town, which is among the most formalized of African cities, case study figures show that the paratransit minibus-taxi sector accounts for half of all public transport trips, and that this figure is rising. Kigali has banned paratransit from the core city area and associated services; however, beyond these boundaries, paratransit remains significant.

The sustained success of the paratransit sector—which typically operates without any subsidies—is leading to increasing recognition of its importance and greater awareness that transit strategies need to build on this success, rather than replace it with more expensive formal solutions.

Mainstreaming paratransit may simply refer to its acceptance as a key part of the network together with planning approaches that recognize this; or it may refer to a more ambitious agenda of enhancing the sector and integrating its services with the formal network.

THE STRENGTHS AND WEAKNESSES OF PARATRANSIT

An examination of fare systems in paratransit requires some understanding of the characteristics of the paratransit sector.

Paratransit reflects a high level of entrepreneurialism. It operates primarily to make money, and while rendering a very important public service, has no public service obligation. It, therefore, only provides services where demand levels warrant them.

It is highly flexible in the way it delivers services. Once the paratransit sector becomes aware of new demand, it generally responds rapidly if it can do so profitably. An important factor in this entrepreneurial and flexible response is the business model whereby the driver's income is largely dependent on the fares earned. The model leads to competition among operators, which explains many of the adverse features of paratransit, including a tendency toward aggressive driver behavior, poor safety standards, and long wait times for vehicles to fill up before departing, often at great inconvenience to passengers. While paratransit drivers may earn as much as formally employed drivers, they tend to work much longer hours to take in sufficient fares, and have fewer workers' rights and benefits.

The vehicles used in paratransit are typically smaller than those used in formal transport, which contributes to their flexibility. They use standard vehicle technology, which is cheaper to buy and run than the buses typically used in formal services.

Despite its strengths, strong evidence suggests that by working collectively rather than in competition with one another, paratransit could provide a substantially better level of service using significantly fewer vehicles, and at the same time remain profitable. While it is risky to extrapolate from one example, the Cape Town project to formalize a minibus-taxi company (Box 5-1) provides very detailed evidence of this success and suggests its applicability more generally.

ORGANIZING PARATRANSIT INTO COMPANIES

The approach taken in projects aimed at improving paratransit services usually revolves around some form of formalization, in exchange for support of some kind.

A fundamental step is to organize vehicle operations so that collectively they provide a better service. Normally, this would be managed by an association to which the various paratransit vehicle owners belong, and might involve quite simple measures, such as introducing queuing at ranks and requiring vehicles to start their journey from the rank after a set time, rather than wait for vehicles to first fill up. However, where the earnings of each operator remain based on the number of passengers carried by his or her own vehicle, the incentives to cooperate are inevitably compromised.

The key step involves the pooling of revenues which are then shared on a rational, agreed basis. This in turn means that how fares are collected becomes critical. An electronic fare system, for example, allows for transparency in how fares are generated while also enabling the immediate pooling of fares into a bank account.

This path to improving paratransit is based on the idea of making operations more efficient through the creation of some form of collective ownership or company that has the power to better direct fleet operations as a whole. The introduction of electronic fare systems could greatly assist with the pooling of fare revenue, creating transparency for the owners. Simultaneously, it would support transitioning drivers from the target system to some form of a wage-earning model.

The challenges should not be underestimated. Moreover, the introduction of an automated fare system should be viewed as supporting the organizational change process and implemented as such; not as the driver of the change process. In numerous cases where the introduction of automated fare systems has been attempted without understanding the organizational change dimension, the outcome has been failure.

DIGITIZATION AS A POSSIBLE APPROACH TO MAINSTREAMING PARATRANSIT

It is conceivable that digitization offers an alternative approach for the improvement of paratransit so long as it is introduced in a manner that is sensitive to organizational and institutional issues.

The ride-hailing service, Uber, pioneered digitization as a mechanism to change the organization of individual taxi services, and this model has been adopted rapidly throughout the globe, with a variety of companies, some of which are very large, offering such services. The YegoMoto case from Kigali operates along similar lines.

Most users of ride-hailing services are exposed to the much more efficient way in which demand is met and payments are made using mobile phone-based apps; vehicles are usually

quickly available upon activating the app. However, of equal importance is the way supply is organized. A prominent manifestation of the gig economy, supply is based on a large number of individual vehicles offering their services through the app. Whereas most vehicle fleets offering transport services to the public are organized to work efficiently on a collective basis through the mechanism of either a private company or the state, in the ride-hailing model, this organization is provided by the app through its back office and algorithms.

It would seem plausible that a similar model may be possible as a mechanism to organize paratransit. Critically, however, it would have to involve some form of revenue pooling; otherwise the individual vehicle will seek to optimize its own revenue rather than the revenue of the collective to which it belongs.

In India, many of the bus operators Chalo works with are small operators, owning between one and three buses. Once Chalo has signed up sufficient operators on a route, part of its service is to better organize the buses as a single collective fleet. While the bus operators Chalo works with in India appear to be somewhat more regulated than paratransit providers in Africa, the organizational aspect of their work is important and shows the potential power of digitization in mainstreaming and improving paratransit.

COULD PARATRANSIT BE A MAJOR BENEFICIARY OF DIGITIZATION?

Thus far, paratransit has typically been viewed as an inferior form of transit that needs to be replaced or transformed into a service that more closely resembles traditional public transport models. However, in a new digitized environment, paratransit could form the basis of a service that in some contexts is superior to the traditional model.

In essence, new digitized technologies enable a much better matching of supply and demand. The smaller vehicle size, greater flexibility and demand responsiveness that characterize paratransit places it in a better position to respond effectively to the new digital environment with new service offerings (Figure 4-2).

Improving efficiency by forming a company or better matching supply and demand through digitization need not be mutually exclusive. However, digitization clearly offers significant possibilities, with or without company formation.

PATHS TO DIGITIZATION

The key challenge rests with introducing such digitization; and three possible paths to digitization present themselves. The first is through a tracking and booking service, such as the SWVL system that is described as part of the Nairobi case study. This is also how Chalo enters a city in India. The second is through service providers recognizing that that they can organize their own services more profitably by digitizing their vehicles as a means to optimize their service plan, such as the Cape Town 7th Avenue Mitchell's Plain case. The third is through fare payment, such as with GONA, or the *matatus* of Nairobi.

No paratransit service in Africa has thus far successfully transitioned to a digitally-enabled service with all the potential efficiencies that could be delivered. Conceptually, it would appear to be possible, although success remains dependent on organizational forms and technical innovations that collectivize revenue risk in some way.

Notes

1. Financial Times 15th November 2019 '£400m unclaimed on Transport for London Oyster cards'.


P.O.S

5. CASE STUDIES

This chapter contains a brief summary of the case studies as a background to the content of the final two chapters. The full case studies will be published separately by SSATP.

5.1 // Cape Town, South Africa

The Cape Town case study focuses on the automated fare system (AFS) and **my**connect card used on the municipality's MyCiTi bus rapid transit (BRT) system.

MyCiTi accounts for about seven percent of total public transport trips in the Cape Town metropolitan area that is also served by conventional buses (21%), commuter rail (21%) and minibus-taxi paratransit (51%). The MyCiTi project, which began operating from 2010, was largely funded by the national government, and intended to drive the modernization of road based public transport in Cape Town as well as the consolidation of public transport responsibilities at the metropolitan level.

Four private companies operate the BRT buses of Cape Town; they were formed predominantly by minibus-taxi owners who were displaced by the BRT system. The companies are contracted on a gross contracting basis and paid by the City of Cape Town, which has overall responsibility for the system. The automated fare system (AFS) operates across all the MyCiTi services and is run by the municipality through a set of private companies specializing in fare collection. It was envisaged that the AFS and **my**connect card system, which were the pioneers for a new national initiative for electronic fare payment, would ultimately grow into an integrated fare system for all public transport in the metropolitan area.

The intention behind the system was to build on South Africa's relatively sophisticated banking system, making the banks key participants in the public transport fare system. By having a standard system nationally, it would also be possible for a single transport card to be used across multiple jurisdictions and services, including on informal paratransit services, and so realize an integrated public transport fare medium across the country.

The system uses an anonymous Europay, Mastercard, Visa (EMV) low value payment (LVP) bank supported smartcard which, in addition to having an EMV e-purse, also has a nationally specified data structure—the National Department of Transport (NDoT) data structure—loaded onto its chip. The data structure on the chip allows the card to be used as a transport card, storing tap-on and tap-off data and other relevant information enabling the appropriate, pre-loaded value to be deducted. MyCiTi fares are distance based, with a base boarding fare; thus, tapping both on and off the system is required to calculate the fare.

The vision for the system went beyond public transport since the smartcard can be used to make general purchases of low value at any retailer that has a POS device able to accept EMV payments.[1] The objective nationally—in addition to creating a transport fare medium that could be used across all public transport services—was to bring a rudimentary level of banking to unbanked populations while reducing the use of cash and, thus, minimizing crime.

The Cape Town automated fare system and **my**connect card is functioning reasonably well, although not chiefly as originally envisaged. High fees for loading the EMV purse—exacerbated by a fee charged for every payment transaction when the card is used on the transport system—led the implementers at the City of Cape Town to use the facility on the NDoT data structure that allows loading transit products, whereby enabling the card to operate much like a closed-transit smartcard and avoid fees. Preloading the card under this arrangement also means that the city benefits from the float used to purchase the transit credit. The banking system has, furthermore, not introduced interoperability as was anticipated, significantly curtailing envisaged loading options, and thus limiting convenience.

The **my**connect and AFS system has proven costly to implement, maintain and operate. While this is not unusual when developing new systems, additional costs were incurred arising from the need to meet a wide range of regulatory conditions related to integration with national banking and payment systems. Yet, the functionality associated with the transport card being a bank card has been little used.

The extension of the system to other modes across the metropolitan area has not yet materialized, partly because of a failure, thus far, to implement policies on the consolidation of public transport responsibilities at city level.

The Cape Town system has the capacity to be adapted fairly easily to operate much like Transport for London's system, with an open, account-based component accepting a diversity of payment channels and a closed **my**connect card that would use only transit products and cease to be a bank card. However, this would depend on the national government making regulatory changes, which it has not yet done. Indeed, the failure of the South African government to make changes to its regulations after its original objectives proved impractical and has prevented a range of obvious innovations that would have increased convenience and reduced costs.

The **my**connect system demonstrates, among other things, the potential and pitfalls of a national government seeking to drive, but also unduly control, the development of local fare payment systems. Ultimately, the system was made to work through local implementers committed to its success by devising practical responses informed by local realities.

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Box 5-1
Fare systems and the formalization of paratransit in South Africa

FORMALIZING SOUTH AFRICA'S PARATRANSIT SECTOR

High levels of violence in South Africa's paratransit industry in the early 1990s, which coincided with the transition to democracy, prompted the new democratic national government to set up a National Taxi Task Team. In 1996, the task team prepared a report recommending a series of measures aimed at bringing greater order to the industry. Based on this report, the government made it compulsory for minibus-taxi operators to belong to associations if they were to get licenses to operate, and established a national body to represent the taxi industry. The government also introduced a capital subsidy equivalent to approximately 15–20% of a new vehicle to encourage licensed operators to recapitalize their fleet.

Among the proposals were recommendations that automated fare systems be introduced into the minibus-taxi industry. Over the last 20 years there have been many attempts to introduce such systems in the minibus-taxi sector, all of which have failed.

The introduction of bus rapid transit (BRT) systems was seen by some as an alternative way of formalizing the paratransit industry—hence the emphasis on the new BRT bus companies being made up of minibus-taxi operators who were displaced by the new BRT services.

However, the new BRT systems have been difficult and expensive to implement and have replaced only a very small fraction of paratransit services. As a result, there is greater recognition of the strengths of the paratransit sector, and a shift toward more incremental approaches to reform—retaining minibuses as the basis for the service. In a project of one association, known as 7th Avenue, Mitchell's Plain in Cape Town, operators are in the process of forming a company, which will enable a much more rational organization of the existing fleet of 78 individually-owned vehicles. Fare revenues are being pooled and a new service plan has been introduced, enabling only 37 vehicles and 3 spares to provide the services previously offered by the 78 vehicles, and at better service levels, including less waiting time at ranks. However, the project is still at an early stage and an automated fare system has yet to be introduced.

The city is considering building on the myconnect system to pay transfer subsidies when paratransit services feed passengers to MyCiTi trunk services. This measure should prove cheaper than providing formal feeder services. It would require introducing some form of device on the participating minibus-taxis.


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5.2 // Kigali, Rwanda

Kigali is the capital and the largest city of the republic of Rwanda with an estimated population of around 1.13 million people in 2012 (JICA, 2019).

The Kigali case study focuses on the successful Tap and Go smartcard-based fare system that functions on the city's formal bus services, and a new solution based on mobile phones and QR codes, which the fare collection company is introducing as an alternative fare payment mechanism on these buses. According to the AC Group, which implemented the system, approximately 300,000 trips are conducted using the Tap and Go system and the mobile phone solution every week.

The Tap and Go card system is an anonymous, closed-loop, card-centric, cashless fare collection solution for city bus trips; once loaded, transport credit cannot be used on other systems.

The modal split in Kigali in 2018 was 40 percent motorbike, 30 percent public transport, and 30 percent private vehicle usage (JICA, 2019). Apart from formal bus services, a significant portion of public transport services is provided by motorcycle taxis also known as moto-taxis. Previously, paratransit minibus-taxi services accounted for a substantial share of public transport services in the city, but have since been excluded by national and city authorities from much of the city and have been replaced by the formal bus services. Bicycle-taxis offer an important last-mile service.

Since a process of public transport reforms began in 2013, the national Rwanda Utilities Regulatory Authority (RURA), which is responsible for transport payments and contracting, has been awarding fixed-term contracts for the provision of formal bus services in Kigali. Routes are divided into four zones, each of which is contracted out separately. Three companies have been servicing the four zones.

The formal bus system in Kigali is completely cashless and uses only the Tap and Go system for fare collection. Bus fares in Kigali City are regulated by RURA at the national level, and consist of a flat fare per route. The flat fare can differ between routes. RURA aims to move to a distance-based or zonal fare system in the future, but at this stage, system constraints preclude this.

The fare collection company has introduced an alternative payment mechanism, using a ticket in the form of a QR code purchased through a mobile app and downloaded onto the mobile phone. The QR code type ticket can be held against the validator to gain entry to the bus.

The initiative to introduce the Tap and Go cashless fare system came from AC Group, a private automated fare collection (AFC) technology company. The firm directly approached the bus operating companies in Kigali City with their cashless fare collection solution, starting with one of the companies. Once they successfully piloted the system, they gained the support of RURA, which effectively made the Tap and Go fare payment system compulsory on all formal bus services in Kigali. However, the business relationship is between the bus companies and AC Group; no contractual agreement exists between AC Group and RURA, and, accordingly, a formal, tender-based procurement process appears to be absent.

The bus contracts with the public authority are net contracts, with the revenue risk lying mainly with the bus companies. AC Group charges a fee of five percent of the fare for its collection services; thus, it also bears some revenue risk. This approach reduces the need for operators to pay high up-front costs.

Kigali is an unusual case in the African context, where the government was able to remove the informal paratransit services from the core city, replacing them with an effective bus system, and enforce the adoption of a cashless fare collection system.

The initiative for adopting the fare system came from the private sector and not from government. A private company saw an opportunity to earn returns by improving the fare collection systems of bus companies, and was willing and able to take a risk on the investments required to do so. As for the business model itself, bus companies were not required to invest capital up-front.

The government responded well to the initiative, creating conditions for a city-wide rollout once the business case had been approved. While AC Group now has a monopoly on fare collection in Kigali, the incentives are structured in such a manner that supports maintaining an efficient and cost-effective system, and investing in further innovations.

It has been reported that the revenue collected by bus operators has increased by 50 percent since the industry wide implementation of the Tap and Go card system on all buses in Kigali.

While this case study focuses on the bus service's Tap and Go fare system, moto-taxi firms using mobile, app-based e-hailing and payment technology are also of interest. The more prominent of the these is YegoMoto, with a smaller firm called PascalMotos also competing in the e-hailing market.

YegoMoto aims to attract moto-taxi drivers and riders to its mobility service platform as a means of formalizing the industry and introducing cashless payment options. It is also adding nontransport services to its ride-hailing app.

5.3 // Lagos, Nigeria

The Lagos case study focuses on the progression of electronic fare systems used on Lagos's BRT service, including the Lagos Connect, Farepay, and Cowry systems.

Lagos is the largest city in Nigeria and the second largest in Africa, with population estimates varying between 14.4 million and 21 million people, depending partly on how widely the metropolitan area is defined.

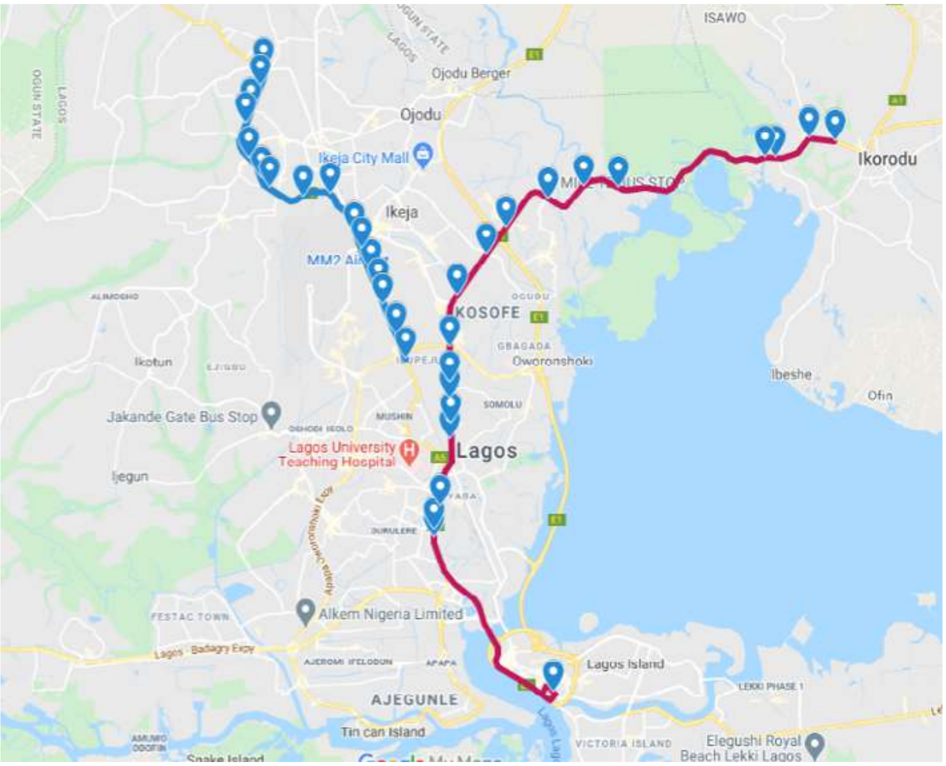
The city is well known for its congestion, which is exacerbated by its geography. The original core of the city, where many of the work opportunities are to be found, is located on a collection of islands separated by creeks around the mouth of the Lagos lagoon on its south western side. The city later expanded into the mainland on the western side of the lagoon, but it is also increasingly spreading along the peninsula south of the lagoon, as well as its northern edge (Map 5-1).

Transport in Lagos is dominated by informal minibus-taxis known as "danfos," which have 14–18 seats, and a much smaller number of midi-buses or "molue," which have up to 50 seats. Estimates in 2016 put the number of danfos operating in the metropolitan area at 75,000; together with the molue, they account for about two-thirds of motorized trips in the metropolitan area.

Starting 2000, major governance reforms were introduced, including the establishment of the Lagos Metropolitan Area Transport Authority (LAMATA) in 2002 and new infrastructure investments such as an initial BRT service.

The first phase of Line 1 of the Lagos BRT system, running north from Lagos Island, was opened in 2008. It consisted of a 22-kilometer bidirectional route, with approximately 65 percent of the route physically separated from the general traffic and another 20 percent by road markings. In 2015, a second phase was implemented to extend the existing route by 15 kilometers on the northwest side of the lagoon to Ikorodu (map 5-1), giving a total route length of 37 kilometers. After the launch of the second phase in March 2016, the total fleet consisted of 460 vehicles. Line 2 was opened in 2020 and runs 13.68 kilometers in a northwesterly direction, starting around the midpoint of Line 1, although the two lines do not intersect.

Initially, the Lagos BRT began operating with only paper tickets using a system run by Ecobank. This was driven by Ecobank needing to recover the loans it had extended for the initial buses. Dovetailing with a wider national government initiative to shift transactions away from cash, the first Lagos BRT electronic fare collection system, known as LagosConnect, started operation in July 2013 alongside the paper system. However, it was discontinued two years later because of a disagreement between one of the bus operators, NURTW BFS, and the technology providers, e-Purse. After the old bus operators were replaced and the right to use the BRT routes was transferred to new bus operators, the same electronic fare collection system was reintroduced in November 2015.[2] LagosConnect is a near field communication (NFC) closed, and card-centric smartcard system.



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Map 5-1
Line 1 and Line 2 of the Lagos BRT

A new Europay, Mastercard, Visa (EMV) card was introduced in 2018 under the name FarePay, with Sterling Bank as the banking partner. Both the LagosConnect and FarePay systems co-exist with a cash-based system. Figures indicate that LagosConnect accounts for less than 15 percent of trips, while FarePay, having at one stage accounted for four percent of trips, has now fallen back to less than one percent of trips.

Line 2 was launched in 2020 with a new, compulsory NFC card system called Cowry; no cash is permitted on this line of the BRT. The Cowry system is a closed, card-centric system—not an EMV system and appears to be working successfully. LAMATA intends to extend the Cowry system on a compulsory basis to replace the other systems on Line 1.

The Lagos BRT system uses a zonal fare structure, requiring smartcard users to tap in and tap out of the bus to ensure that they are charged the correct amount. Passengers that fail to tap out their smartcards before alighting from a bus will have the largest possible fare for the route deducted from their card or FarePay account.

Given the account-based nature of the FarePay system, connectivity problems may arise, making immediate fare calculation and debit impossible. If the user's account has not been debited immediately, it will be debited within a 24-hour period. If the user's account is not sufficiently funded at the time that a debit is to be passed, the FarePay card is blacklisted. The user will not be able to use the card in question until the account is sufficiently funded and the debit entry has passed.

Given that the introduction of the Cowry system is so recent, it is difficult to assess definitively; however, a few significant observations can be made at this stage.

First, the introduction of the BRT system and its fare system only became feasible after the establishment of a metropolitan transport authority capable of marshalling the different stakeholders operating within a complex governance environment.

Second, the electronic fare collection systems which charge according to the number of zones traveled have been functioning reasonably successfully in Lagos.

Third, where those running the system have been unable or unwilling to enforce electronic ticketing as the only form of fare payment permitted on the BRT, less than a fifth of riders use electronic tickets; on Line 1, the electronic system exists alongside a system of paper tickets that can be purchased prior to entry onto the vehicle.

Fourth, based on the experience on Line 1, when launching Line 2, LAMATA opted for a non-EMV, closed NFC system that is compulsory; there appears to be general satisfaction with this approach.


OJOTA

5.4 // Maputo, Mozambique

The Maputo case study examines the new FAMBA smartcard fare payment system currently being introduced by the newly established Maputo Transit Authority (AMT) for use on recently established bus services and, ultimately, all transit in Maputo.

The capital of Mozambique, Maputo, is located in the south of the country on the southern part of the African east coast. The urban area has outgrown the municipality of Maputo itself, with the population of the overall urban agglomeration now in the region of three million people. It accounts for more than 20 percent of the national gross domestic product (GDP), and is the closest port to South Africa's main economic heartland of Gauteng.

Forty-five percent of trips are nonmotorized, and the estimated 4,500 loosely-regulated paratransit *chapas* - 15 and 25 seater vehicles - that operate on nearly 130 routes account for approximately another third. While roads in the core Maputo municipal area are paved, many roads on the outskirts are not. These unpaved roads are not served by buses and minibuses, only by "myloves"—flatbed trucks where people clutch onto one another to avoid falling off, hence the name—and motorcycle taxis.

Despite the rather low number of existing private cars, Maputo is experiencing a rise in traffic congestion. It is projected to result in the kind of gridlock that affects many larger African cities and is already significantly constraining road-based public transport operations.


3506 TBA

The initial focus of the new FAMBA fare system being introduced by AMT is on 400 buses that were purchased by the national government in 2017; it will also be offered to minibus or minivan operators at a subsidized rate equivalent to approximately 30 percent of the cost. Operators wishing to access these buses were required to form cooperatives, of which there are now eight, with fleets ranging from 30 to 70 vehicles, operating along six main corridors in Maputo. The purchase of the vehicles originated from a scheme to support public transport services in the face of a severe financial crisis that led to sharp rises in fuel costs.

The fare system being implemented on these fleets as of late 2020 is intended to ultimately be extended as an integrated fare system functioning across all public transport services in the metropolitan area, including the two envisaged BRT routes.

AMT has opted for a pure account-based, back office-centric fare system design, although some information will be held on the smartcard to assist in assessing whether access to the bus can be permitted and to address anticipated connectivity problems. Fare payments in cash will not be allowed once the fare collection equipment has been installed onto the buses. Instead, users will be required to purchase and make use of the AMT's Mifare type smartcard, tapping it at validators both on entering and exiting the bus. Each card will have a unique identifier that will be linked to an account with stored money value held in the fare system back office; when the card is used, value will be deducted.

The user will purchase the card at one of 52 kiosks where associated accounts can also be loaded using either physical cash, credit or debit cards, or mobile money services such as M-Pesa, M-kesh, and e-Mola. Initially, these kiosks will be the only channel available for this purpose, but it is envisaged that the facility will be extended to ordinary retailers.

Subsequently, as implementation progresses, the system will be opened to Europay, Mastercard, Visa (EMV) contactless bank supported smartcards, although the card will have to first be registered to an account in the fare system back office.

The fare system will not only be a mechanism for fare payment, it will also calculate fares, albeit as a simple aggregative calculation, and charge these automatically. Through links to onboard validators with warning sounds, it will assist in controlling access to the transport system. Furthermore, the system is designed to allow users to make third party micropayments, such as hospital, water, electricity and school fees, from his or her personal account, and receive payments from third parties; for example, a government grant payment.

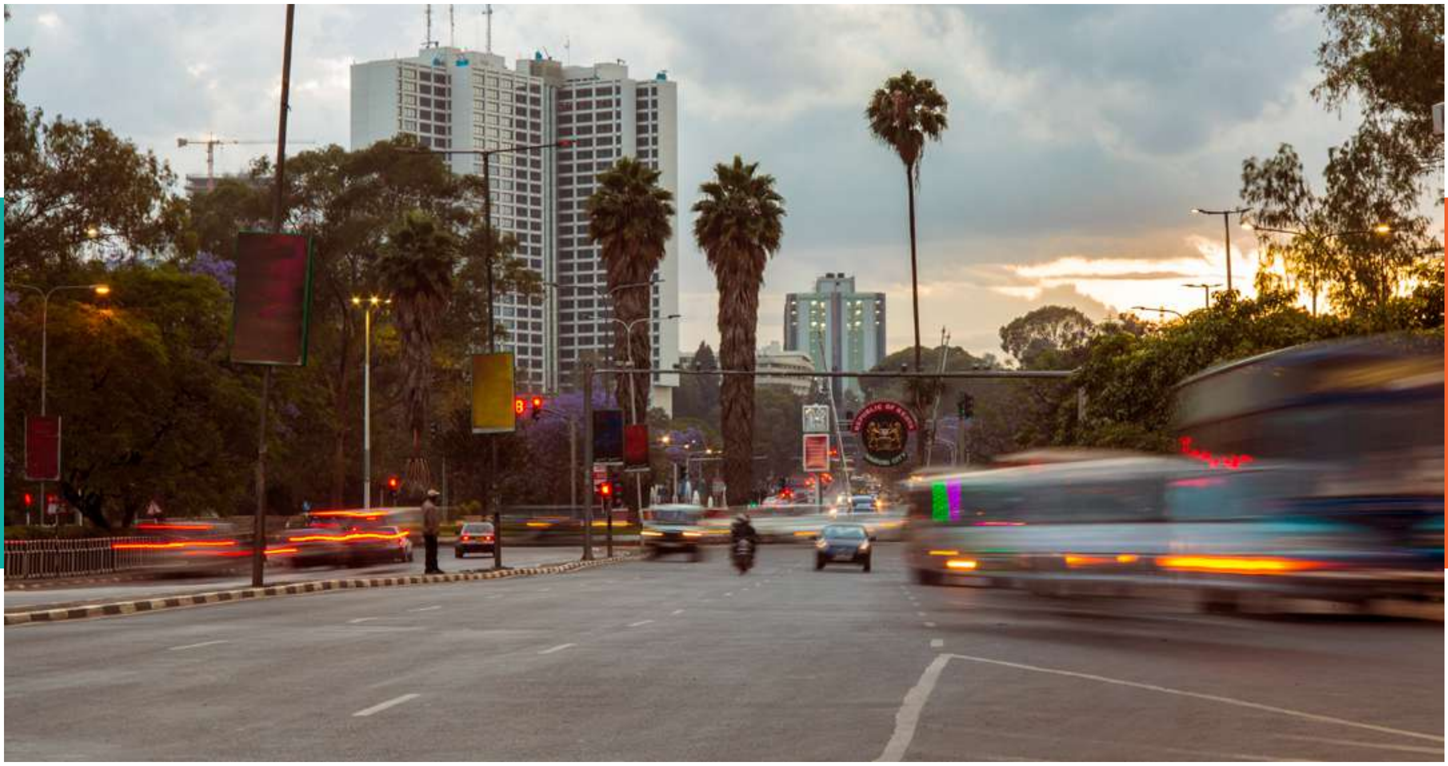
The technology was specified with the objective of lowering the cost of designing, implementing, and operating the fare system. It can be extended with relative ease, providing integrated ticketing and interoperability across all public transport services within the Metropolitan Area of Maputo, and eventually across Mozambique.

The system enables taking full advantage of a wide range of fare media that may potentially be used for paying travel fares or for loading money, so long as such media can be securely linked to each individual's back office account. If EMV contactless cards become a common mechanism for payments and low functionality banking, in time, users will be able to easily upgrade from Mifare to EMV contactless cards.

The service provider has been procured on a concession basis for a period of ten years through a transparent and competitive tendering process for which approximately 15 companies submitted bids. The winning bidder is required to fund the entire project up front, recovering its investment and earning returns on the basis of a fee for each fare validation. The concessionaire, therefore, shares the ridership risk.

The comprehensive embracing of account-based ticketing, the scope for it to be extended into other micropayments and receipt of grants, as well as the procurement approach based on a concession with no up-front capital costs for AMT are significant.

Conceptually, the approach appears to be well conceived, although the challenges of implementation are still to be encountered. The four most critical risks include gaining the trust of those already providing the service, fully resolving financial arrangements, addressing connectivity problems, and the general challenges of any implementation. If a system is able to manage all these risks reasonably successfully, it will represent a significant advance within the region.



5.5 // Nairobi, Kenya

Significant automated fare systems operating within formal bus services are to be found in the majority of the other case studies supporting this report. But despite Nairobi being one of the key centres for software development in Africa, it lacks such a system. On numerous occasions, the authorities have attempted to introduce cashless fare payment media for public transport, but these have not been a success, partly because of the limited presence of formal public transport services in the city. Instead, the emphasis in Nairobi is on innovation within paratransit and small, more formal transport businesses.

The case study focuses on two innovations: the use of M-Pesa to pay directly for transport services, especially *matatus*, and the SWVL bus booking and payment system, while also describing some of the failed attempts to introduce other noncash systems. It also comments on a scheme called SafeBoda, an uber-type mobile phone app for *bodaboda* motorcycle taxis. Because SafeBoda functions essentially in the same way as Uber, however, it is not discussed in this report.

Nairobi is the capital city of Kenya with a population of 4.4 million. Approximately 40 percent of all trips are on foot, while just less than a third are on paratransit minibuses known as *matatus*. An estimated 20,000 *matatus* operate in Nairobi; they have a varied seating capacity of between 14 and 33 passengers.

All *matatus* are privately owned and while some owners may have just one vehicle, others may own an entire fleet. In Kenyan media, the *matatu* industry has become notorious for inefficiency, congestion, violent criminality, pollution and corruption. On the other hand, it offers cheap transport for hundreds of thousands of Nairobi commuters, is highly flexible, and has a very vibrant *matatu* street culture. Drivers are employed by *matatu* owners who set a daily financial target for them; the target is effectively a rental fee to work a given route. *Matatu* owners are organized into associations called Savings and Credit Cooperative Organizations, usually referred to as SACCOs. SACCO members work together to increase the scale and profitability of operations.

The relative absence of formal public transport services is partly attributable to the absence of clear public transport governance arrangements. The newly established Nairobi Metropolitan Transport Authority (NaMATA) is mandated to address this deficiency, but it is too new to have had a significant impact so far.

M-PESA

Various cashless payment systems, chiefly smartcards, have been implemented in Nairobi since around 2010 with very little success. However, M-Pesa, which has already been described in detail, is now used quite widely as a payment mechanism on Nairobi's public transport system.

In assessing its use for public transport payment, it is important to recognize that M-Pesa is only a fare payment mechanism. It plays no role in calculating the fare, and its only role in allowing or disallowing access to the vehicle is the SMS sent to the conductor to verify payment. Its relative success as a fare payment medium, in contrast with other unsuccessful endeavors, is probably attributable to three key factors.

First, it is already widely used as a virtual payment mechanism. Most passengers will have an M-Pesa account and use it to pay for public transport services; in contrast to the failed transport cards, for example, they would require no familiarization with new systems or technology.

Second, unlike attempts made in 2014 to force a shift to new technologies, the introduction of M-Pesa use has been incremental. It is only used to the extent both service providers and passengers are willing to do so. Consequently, there is no basis for collective resistance, as was the case with interventions aimed at forcing a shift.

Third, evidence suggests that where M-Pesa has been introduced as a mechanism to pay for public transport, no significant changes have been made to the flow of funds, The process has merely been digitized, shifting from coins and notes to a digital message between mobile phones, where the receiver of the digital payment is the same person who previously received and controlled the cash.

Some malpractices may be addressed by replacing coins and notes. For example, transactions become more transparent and the scope for theft and bribery is reduced. However, the critical change occurs when a shift to M-Pesa is associated with a shift in how value flows, typically resulting in cash by-passing the conductor and flowing directly into the vehicle owner's account. Some key stakeholders are affected by this. The driver or conductor loses control over the cash and the nature of the employment relationship changes in the owner's favor. At the same time, while benefitting from better information on revenue, owners may now be more exposed to tax authorities who could get access to information on cash flows.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While the shift to M-Pesa does offer some improvements on convenience, it needs to be understood in the context of this interplay of interests. Given the widespread usage and convenience of M-Pesa, the key question is why cash is still used at all. This is likely best explained in terms of this interplay of interests, with COVID-19 offering an opportunity for the beneficiaries of virtual payment to advance the shift.

SWVL

SWVL, which was originally founded in Egypt, describes itself as "Like Uber, but for buses." It is a bus-hailing service available in Kenya, Uganda, Pakistan, and Egypt, with ambitions to expand in other parts of Africa and Asia.

The service comprises organized buses plying specific routes at fixed schedules, with bookings all done through the SWVL app. Free Wi-Fi is available on the vehicles. SWVL operates about 55 daily routes within Nairobi, and is venturing into other cities in Kenya. The key value of SWVL lies in being able to book a seat, select a pick-up point, and monitor the progress of the vehicle to be boarded. While payment can be made through the app, onboard payment with cash or M-Pesa is also allowed.

The SWVL service does not target *matatu* or *bodaboda* users—who are mostly low-income earners—but rather those who drive their own cars to work or use ride-hailing apps such as Safeboda or Uber, and who seek a comfortable and reliable commute at a lower price than private alternatives. This has allowed SWVL to operate with very little resistance from the powerful *matatu* industry.

SWVL is not a large service. However, it represents an important innovation which has the potential to grow significantly and spawn competitors operating along similar lines. It is a private sector innovation which would not have been possible a few years ago, having emerged as a result of the development of mobile phone technologies and new practices pioneered by ride-hailing companies. While essentially a booking service for higher-end public transport users, its use of 11- to 22-seater shuttle type vehicles offers the potential to combine some of the demand responsive features of *matatus*, and even individualized ride-hailing services, with collective public transport services.

5.6 // Chalo Pvt. Ltd., India

During the study, an environmental scan of a number of systems outside Africa was conducted to identify innovative practices that may be relevant to African contexts. On this basis, Chalo, a newly established private company in India that is innovating across a number of Indian cities using information and communication technologies (ICT), was selected for further analysis. While Chalo was not investigated to the same level of detail as the five African case studies, the findings are of interest because of the way Chalo addresses some of the issues that have been encountered in the African cases.

Chalo, which began operating in India in 2018, is an example of a private company that partners with bus operators to improve services through the use of cost-effective modern technologies, including tracking, fare payment, and operational support systems. It grew rapidly since launching in Bhopal in 2018, and now has a presence in 30 Indian cities. The Chalo tracking app was introduced in half of these cities, but in 15 of them, it was combined with the Chalo fare payment system. The rapid growth suggests a need for the kind of innovation it delivers.

Chalo began as a tracking service available to bus users, and progressed first into fare payments and then into operational support for bus operators, developing its business model incrementally based on experience, rooted in its original objective of providing a mobile-enabled, app-based service to the user.

Of interest to this study is its institutional form, namely a private company offering fare payments and related services to the bus industry on an outsourced basis; and the context, which includes a wide range of differently-sized bus companies operating across many Indian cities where average incomes are similar to those in Africa. Chalo developed its own technology, among which is a handheld device used by bus conductors that accepts cash and for which it prints a ticket, a proprietary smartcard called a ChaloCard, and mobile phone generated QR codes. Chalo's business model is particularly interesting. It earns returns based on increased ridership, and positions itself as a consumer brand by not merely providing services to bus operators, but tying its success to the improvement of the bus services with which it partners.

Chalo was founded in 2014, initially developing the core technology platforms for live bus tracking—known as automated vehicle location system (AVLS), automated fare collection systems (AFCS), electronic ticketing machines (ETIMs), mobile tickets, and prepaid contactless card systems. In May 2018, it launched in Bhopal with the live tracking of all the city buses.

An important part of the Chalo strategy is its attempts to work with small bus operators. This is of particular relevance to the African context. While the largest cities tend to have big bus companies, it is estimated that more than 70 percent of buses in India are run by small informal operators that own between one and three buses. According to Chalo, these operators tend to be incapable of monitoring their bus crews adequately, do not have the resources to invest in technology or operational improvements, and lose 15–20 percent of earnings to revenue pilferage because all tickets are paid with cash. Overall, bus occupancy averages less than 35 percent, with loss-making services reflected in deteriorating assets and resultant poor service levels.

In response, Chalo developed a variety of services offered to passengers and operators. Passengers are offered a free app that enables them to track buses and provides other information such as an assessment of how full oncoming buses are so passengers can choose to wait for the next bus. Chalo also offers a variety of convenient payment and fare options.

Chalo's preferred model, especially when working with small operators, is to take over the responsibility for fare collection, providing all equipment, including in-bus ticketing devices, GPS systems, as well as the automated fare collection system, mobile tickets and cards for a small fixed fee of approximately US$2.00 per bus per day. The company then takes a portion of the bus revenue exceeding an agreed baseline amount calculated according to the average revenue generated prior to implementing the Chalo technology. The increased revenue is generated by reducing leakage and by using Chalo's capabilities, working with the bus operator to improve the service and increase ridership.

In essence, it would appear that, from the point of view of the operator, Chalo effectively turns a net-type contract into a gross-type contract, guaranteeing the operator revenue levels usually slightly above what they had been earning previously, and paying them on a predictable basis. Chalo then makes its returns from the additional revenue earned from enhanced services.

Recognizing that cash remains the preferred medium for many users, Chalo incorporated cash payments into all its ticket apps and the AFCS solution itself. While the solution can work with a cash system operating in parallel, the operator gains most if every single ticket issued is recorded on the AFCS, irrespective of the mode of payment. Cash tickets are thus issued from Chalo ticket apps and stored in the Chalo AFCS. This means that the system generates comprehensive data which can be used for improving operations and better tailoring supply to demand.

Chalo is a significant example of an emerging institutional form for fare collection, namely a private company offering fare payments and related services to the bus industry on an outsourced basis. In addition, and of particular interest, is the manner in which its business model serves to directly align its interests with the improvement of customer service and more efficient operations, resulting in it becoming increasingly involved in supporting operational improvements. The incremental development of Chalo's model since it began as a tracking app has retained a focus on customer service, extending first to fare payment and subsequently to operational improvements.

While there are differences between the operating context in India and typical paratransit operations in Africa, Chalo has begun to tackle some of the key challenges facing small operators, including changing the employment conditions of drivers and conductors.

Chalo has been operating for less than three years. It has received significant venture capital support[3] which has enabled it to develop its technology and establish itself across India. As it grows, it will face new challenges. For example, where it achieves dominance in a city, it remains to be seen whether or in what contexts public authorities will accept that dominance, and how the firm will navigate these relationships. However, given its innovative approaches and its rapid growth thus far, it is undoubtedly a significant case to watch.

Notes

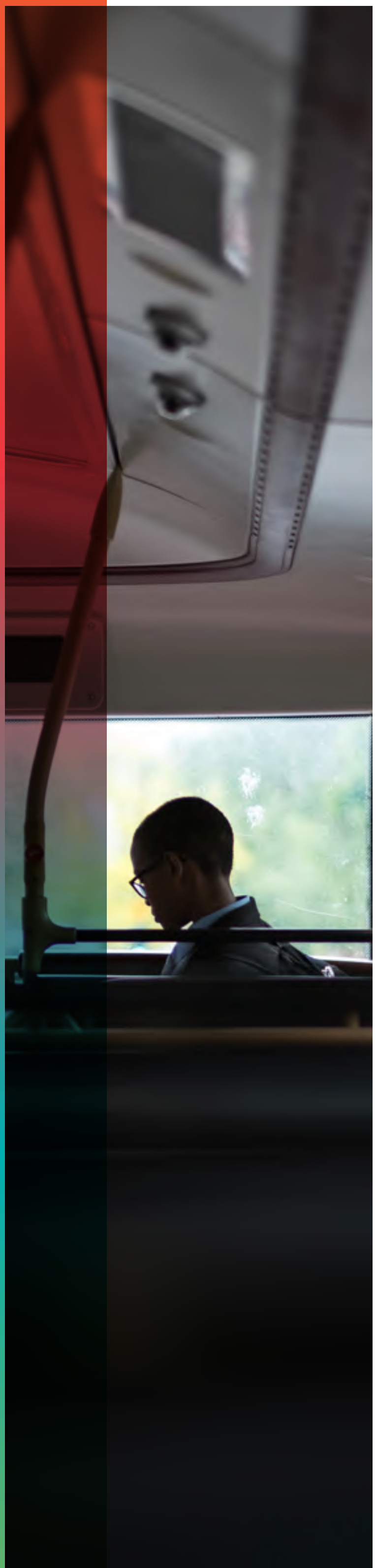
1. The e-purse can be loaded with up to R1500 at any one time (with a maximum of R3000 per month) and be used for purchases of up to R200 at a time.
2. It was only officially launched in 2017.
3. Approximately US$30 million.

Reference

JICA. 2019. Data Collection Survey on Development of Urban Transport System in Kigali City https://openjicareport.jica.go.jp/pdf/12345005_01.pdf

6. KEY TRENDS

This chapter identifies key emerging trends and other characteristics in fare systems and fare payment in Africa based on the case studies summarized earlier.



6.1 // Scheme owners, beneficiaries and promoters

Initiatives for fare system innovations seem to come from a variety of sources but work best when there is an optimal balance between stakeholder interests.

Although not necessarily the most innovative technologically, arguably the most successful initiative from among the five African cases studies has been the implementation of the Tap and Go system in Kigali. This has much to do with the way in which different stakeholder interests are balanced, possibly resulting from the way the system came about. AC Group, the fare system company, was able to convince the bus operating company to allow it to pilot its system. When it proved successful, improving bus financials while also earning a sufficient return for the fare company, national authorities supported its roll-out to the rest of the city, but did not dictate how it should work.

The result is a cost-effective and well-functioning system where the interests of all the stakeholders are well balanced and incentivized, and which offers a good platform for ongoing innovation through a form of public–private partnership. The private fare collection company could become too entrenched and then exploit its monopoly position, but it is arguably more in its interests to continually improve its performance while containing its fee, innovating further and expanding into other markets.

The Chalo system in India is particularly interesting, reflecting an independent operator approaching bus operators, similar to AC Group in Kigali. While AC Group earns fees as a percentage of transactions, Chalo typically guarantees the operator an agreed recurrent payment based on historic collections, and takes a share of revenue over and above that benchmark. Chalo is thus incentivized to actively improve bus operations and fare revenue levels.

Quite often, national public authorities, with their more substantial resources and access to technical capabilities, play a pivotal role in driving the introduction of a system. While there can be merit in this—especially in low-resourced countries with a single core urban center requiring such a system—the experience of national involvement has had mixed results. National authorities have attempted many times to introduce card payment systems in Nairobi, for example, all of which failed. In Cape Town, the national government imposed its own fare system concept, which while innovative and successfully implemented, resulted in very high costs and largely failed to realize some of the key anticipated efficiencies. The local municipality was itself innovative in adapting the concept to make it work better, but, thereafter, the national government ultimately failed to adjust its regulations in ways which would have enabled much improved results. A new nationally-driven system from the national roads authority (SANRAL) could well repeat many of the same errors arising from excessive national involvement in fare system details.

One of the motivations behind national governments' support for such systems is often a desire to shift toward a cashless economy in general, and to introduce efficiencies that may have little to do with public transport. This motivation is clearly evident in the case studies of Kenya, South Africa, and Nigeria, and may be present in all the case study countries. The Maputo system is intended to provide a mechanism for payments beyond transport, both from and to the individual transport accounts that are to be established as part of the envisaged system, but yet to be implemented.

In all the case studies, the fare system under discussion is confined to one service, except for the M-Pesa payment phenomenon in Nairobi, which is not a fare system but merely a payment mechanism. Yet, it is widely acknowledged that addressing public transport needs in cities requires city- or metropolitan-wide multimodal solutions. The existence of a city-wide authority that assumes responsibility for transport is critical for doing so successfully. In Lagos, the creation of LAMATA has been highly significant in advancing the agenda for public transport in the metropolitan area. In Kigali, the local city government, which covers the whole metropolitan area, works in conjunction with various national regulatory and infrastructure institutions. In Cape Town, the metropolitan-wide municipality is envisaged as the key locus of responsibility for public transport, with the MyCiTi project an important step toward its realization. The Maputo project is being driven by a newly created transport authority for the metropolitan area. The Nairobi Metropolitan Transport Authority (NaMATA) has now been created in Kenya. These local, metropolitan-wide institutions will be vital in improving integration across services, including fare systems that support such integration. With the exception of NaMATA, which has not been in place long enough to make a clear impact, they have all played a significant role in driving the fare systems examined in the case studies.

Significant international competition to facilitate payments is developing among financial technology and Internet companies as part of their drive to replicate the super app model. Efforts by Safaricom to extend the use of M-Pesa to public transport in Nairobi in response to the COVID-19 pandemic is consistent with evidence of this trend. Moves by AC Group in Kigali as well as YegoMoto to extend apps for public transport to a wider e-commerce market are signs that such developments may not be far off.

Interestingly, in none of the case studies were the fare system innovations driven by existing bus operators themselves, although once they saw the benefits they were supportive, as in Kigali. This may have simply been by chance or because the fare systems were introduced as part of wider public transport initiatives often driven by government, as in Lagos, Cape Town and Maputo. Nevertheless, once the shift is made from fare payments accruing to individual vehicles carrying passengers to some kind of revenue pooling mechanism, the realized efficiencies and improved transparency make the introduction of automated fare systems an obvious choice.

In Lagos and Maputo, an important motivation was the desire by the government or its agents—who are directly or indirectly responsible for financing buses—to insert themselves into the flow of payments whereby enabling them to collect capital charges.

A private entrepreneur originating in Egypt introduced the SWVL system in Nairobi, seeking to innovate within the transport sector using modern mobile phone-enabled technologies.

The one instance where passengers have arguably driven the change is in Nairobi, where M-Pesa users have sought a more convenient alternative to cash when paying on matatus. This transition could not happen independently of the service provider, and succeeded because of the vehicle owner's support.

6.2 // Use of micropayment and other payment channels

In all the case studies other than South Africa, mobile money has featured as an option for payment. In most cases, it has been a means to load value onto a card, along with cash or, in some cases, bank accounts and ATMs. With a vigorous new attempt to introduce mobile money in South Africa, this payment option may extend there as well.

In Nairobi, M-Pesa is used to pay directly on *matatus* and the SWVL system, but these are micro payments made into a specified account once the amount owed has been determined. M-Pesa has not been directly integrated into any fare payment systems in the way credit and debit cards are used in the open Transport for London system – or as is planned for Maputo and, potentially, Cape Town.

While not the focus of the Lagos study, the GONA service in that city demonstrates the paratransit operators' use of QR codes to collect fares from passengers using smartphones. The vehicle has a QR code on the dashboard or window used by the rider to pay electronically for the fare. In other instances, such as the system in Kigali and the one planned for Maputo, the QR code is either generated on the rider's mobile phone or purchased as a printed ticket, and held against the validator in the vehicle to effect payment.

Cape Town's **my**connect card is a low value payment (LVP) EMV bank card, which can be loaded with cash, or from a bank account or ATM, and used for micropayments at EMV-compliant terminals. However, this capability, which was seen as one of the most important innovations by the system designers, has hardly been used. Lagos's EMV-based FarePay has also not proven as successful as was anticipated.

It is envisaged that the accounts individuals will set up for Maputo's account-based fare system will also have the capacity to be used to make small payments such as school fees and receive payments such as government grants. This may eventually lead to public transport users being able to use their transport cards to make micropayments.

6.3 // Relationships of scheme owners with the transport stakeholders

In none of the cases examined does ownership of the fare system rest in the hands of the bus operator; although in the SWVL system, the service originates with the booking system owners who then lease vehicles to supply the service. In Cape Town, a private bus operator has implemented a Mifare system under its direct ownership and control, but this case was not examined in the study.

The fare system scheme lies within a nexus of contractual arrangements among various transport stakeholders, where the relationship between fare scheme owners and the other transport stakeholders depends on the overall public transport business model. The critical issue is how revenue risk is allocated; those carrying the primary revenue risk will ultimately seek to have control over the collection of fares through contractual arrangements of some sort.

Under a net contracting arrangement, the bus operator will need to be able to hold the fare scheme owner to account. The Kigali case is interesting in that the AC Group in charge of the fare system is contracted to the bus companies and not the government; yet the government mandated all the bus companies to use the system once it had been proven with one of the companies.

It is not yet clear how bus companies will be remunerated under the Maputo scheme, but it would appear that this is to be done initially on a net basis. Yet, the fare system is being introduced at the behest of AMT, the metropolitan transport authority. This could be partly justified by the public authorities seeking to get access to financial flows to claim repayments on the buses, as was the rationale for the bank-driven implementation of the original fare system on the Lagos BRT.

In both the Kigali and the planned Maputo cases, the fare scheme owner is or will be paid based on a percentage of fare revenue collected. Thus, while the bus operators are the key bearers of revenue risk, the fare scheme owners' revenue is entirely dependent on the amount of revenue collected, together with the portion of that paid over to the fare collector. Both the fare scheme owner and the bus operators need the whole system to work well.

Under a gross contract where bus companies are paid out of the collectively earned fare revenues, the bus companies should be able to exercise control together. None of the case studies fall into this category. Under a public responsibility gross contract, revenue risk ultimately lies with the public authority. The Cape Town case falls into this category as the fare system owner is the municipality.

The Chalo system could be viewed as taking revenue risk away from the operator, in essence transforming a net contract into a gross contract. This makes Chalo significantly dependent on the success of the service, and has led it to becoming increasingly involved in bus operation improvements.

Whichever the case, the fare system tends to be a key channel for engagement between users and bus operators. Both need to be able to hold the other accountable to ensure optimal performance.

One of the most important conclusions to be drawn from the study is that even if the operator does not initially drive the fare system innovation, close alignment between the interests of the operator and the fare system innovator is critical for an effective partnership. This is arguably why innovations driven by national governments tend to be less successful than anticipated; they are often driven by interests extraneous to the success of the transport operation itself and are not sufficiently appreciative of practical considerations. Where a government initiates the innovation, city-level transport authorities are likely to be more successful, but ultimately, the most successful projects are likely to flow from an alignment of interests among fare scheme owners, those with operational responsibility and those bearing revenue risk.

6.4 // Proposition to the customers: incentives and charging structure

Three separate issues can be identified: the structure of the fares, the convenience of using the fare system, and its costs to the customer.

The complexity of charging a distance-based fare on an automated fare system usually means that most fares are built around a flat fare structure. A purely flat fare structure could contain variations, usually achieved by setting different flat fares per route (Kigali), or by building the fare around journey segments that each have a flat fare and are aggregated to establish the full fare for the journey as in Lagos and Maputo. The Cape Town case appears to be the only one among the case studies where fares charged are rigorously related to distance.

Any fare that differs in some way according to distance traveled, including zonal fares, requires both a tap-on and a tap-off to ascertain the distance. Accurate measurement of the distance increases the complexity and the scope for error—if, for example, the GPS or communication systems fail.

In other words, the use of automated fare systems could arguably have some impact on fare structures. It may enable greater complexity and sophistication in setting fares or it may restrict the options available. This may benefit the user or the service provider depending on the precise circumstances. Account-based systems—where the user taps on and off, and much of the fare calculation is done in the back-office and charged to an identifiable person—are able to support the most complex of fare structures.

Advocates of automated fare systems generally argue that they are more convenient for the customer. However, smartcards are not always convenient to load. There may be queues to load and loading may need to be done at a different place from where the passenger wishes to board. The inconvenience is exacerbated if the card runs out of credit at a key moment when it needs to be used and where loading is not easy. Furthermore, many public transport users in African cities are relatively poor and unable to afford loading large amounts of credit; for these users the inconvenience is multiplied.

Fare systems often charge a loading fee and may also charge a transaction fee. An important reason why the EMV component of Cape Town's myconnect card has been so unsuccessful, and why the Mover Points system was introduced, has been the high loading and transaction fees. Because there is a flat fee for loading, the percentage of the total load deducted is small if large amounts of credit are loaded. But since most users cannot afford big loads, the percentage fee is significant and incurred by those who can least afford it. Hence, the municipality innovated to use an alternative facility designed into the fare system, reducing loading costs and covering the costs itself.

The cost of the fare system may not be evident to the user, but ultimately this cost is incorporated into the fare. If the efficiencies gained—such as lower fare evasion and theft, quicker boarding procedures and better service enabled by data—outweigh the costs of the system, then it is ultimately beneficial to the user. But, this may not always be the case.

The trend toward finding easier ways to load—especially using mobile money or credit or debit cards, and being able to do this autonomously without using a vendor—is of very substantial importance. Having this kind of facility for loading is not only much more convenient for the customer, but also much cheaper.

6.5 // Proposition to the transport providers

Ultimately, the fares must cover the cost of the fare system; and the higher the cost, the fewer opportunities for other improvements, such as better-quality vehicles or more frequent services. If the efficiencies introduced by the implementation of an automated fare system outweigh its costs, then all parties benefit.

The key question then becomes whether the fare system provider is being paid an appropriate fee for the service provided or is making unreasonably high profits. Ideally, a tendering process should optimize value for money; however, this is not always as simple as it may seem.

None of the bus operators in the case studies have themselves had to bear the capital cost of developing the fare system and providing the related infrastructure. In most cases, these costs are paid by levying a fee on the fares collected, which clearly helps the bus operator or transport system owner manage risk while avoiding the up-front capital payments.

However, setting this fee becomes complex because of many risks related not only to costs, but also to ridership levels and how fares are regulated. The fee will usually be set to ensure a positive return based on a fairly lengthy time period. The risk of getting this wrong is high; and fare system providers are often prompted to add significant fees to mitigate this risk.

The fee charged for the fare system in Kigali was negotiated between the fare system provider and the bus companies who bore the revenue risk. In Cape Town, the fee has essentially been covered by generous grants from the national government. In Maputo, the fee is yet to be set and constitutes a significant unknown for all parties. Where ridership levels are already known, however, the risks are much more contained. Given a fare system cost structure of high initial costs and low marginal costs, it is very difficult to set a fee per transaction when the number of riders has to be estimated, not only for an initial period but also over the long term, as is the case in Maputo.

The Chalo case is of particular interest in the way it addresses this issue; the operator is guaranteed at least the revenue previously earned, while Chalo takes the revenue risk and benefits from increased ridership. This would clearly be an attractive arrangement to bus operators who are struggling financially and value the security of this arrangement.

Developing mechanisms to allocate, price, and manage risk fairly is of key importance.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6.6 // Technology deployed

In the majority of the cases studied, the fare systems are built around smartcard technologies. However, a clear trend toward greater use of mobile phones is becoming evident.

Mobile money is commonly used to load transport cards or pay the fare directly as with the Nairobi matatus or SWVL. But mobile technologies are also beginning to replace cards as the device used on systems. The Kigali Tap and Go option allows a ticket in the form of a QR code to be purchased online and used on the system. The Maputo system is also intended to incorporate mobile phone-enabled QR code capability.

The GONA system in Lagos, although not a focus of the case study, is an interesting example of the transport operator using a QR code to enable a rider to pay the fare into an account using a smartphone. This replicates the model of mobile phone-based payment that is now dominant in China in the retail sector. The user's mobile phone is the mechanism for communicating the electronic payment to the system rather than a device on the vehicle.

Of all the African systems assessed, SWVL is the most advanced in using the mobile phone as a device to better match supply and demand within a context of potentially flexible routing, while also providing for an app-based mobile payment option alongside the cash and M-Pesa options. Chalo in India, which originated as a tracking service, has a strong emphasis on using data to better tailor services to demand.

Most of the smartcard systems are largely card-centric. Information, including value, is stored on the card itself, with value being deducted when the card is swiped. The amount is usually deducted on entry to the system, with the vehicle validator set to deduct the appropriate amount, as in Kigali. The Cape Town system is card centric yet provides for a highly variegated distance-based fare. Because the card is also an LVP bankcard, the system is more expensive.

The planned Maputo system reflects what appears to be an international trend toward account-based systems where the user taps on and off. Account-based systems are best placed to support the most complex of fare arrangements at relatively low cost. They do depend, however, on good IT connectivity and accuracy in linking the users to their account. If the identity of the user can be clearly and accurately established, complex discounts based, for example, on age or extent or nature of travel are easily administered. The Maputo system, if successful, is likely to support a trend toward this type of technology.

Account-based systems can be designed using smartcards or phones; the crucial issues are accuracy in identifying the passenger and linking that person to the correct account, and access control that depends on whether sufficient credit exists, especially when connectivity is poor.

6.7 // Achievement levels of anticipated outcomes

The case studies did not gain detailed insight into what the original objectives were in introducing each fare system, and have therefore not established whether these have been achieved. In the case study analysis, some attention was given to failed attempts to introduce new systems, but in most cases, the fact that the system is in operation implied a reasonable degree of success. Moreover, it is usually not in the interests of most parties to advertise their failures. For these reasons, it is difficult to make a clear assessment of the extent to which anticipated outcomes have been achieved.

Assessing benefits against costs, even at a qualitative level, is also challenging. Given that the most important benefits lie arguably in the potential for using the data generated by the system to improve bus operations, whether those benefits are realized may have little to do with the fare project itself.

In the Cape Town case, it is possible to assert that the original objectives of the system were not realized as intended. The objective was to introduce anonymous, EMV-compliant, LVP bankcards as fare media. Every bankcard issued in the country was ultimately intended to also contain a nationally mandated transport system data structure on its chip that, in conjunction with validators on vehicles or stations, would enable the appropriate fare to be deducted. These cards were intended not only to serve as a medium for payment across all public transport systems in the country, but also function as a rudimentary system for receiving electronic payments and making small purchases. This vision was never realized; instead the local implementing authority, the City of Cape Town municipality, innovated with the transport data structure on the card and built an alternative system, using what was intended only to be a mechanism for purchasing monthly passes. The Cape Town MyCiTi system does not cover operating costs and the fare system has proven expensive. It may, however, have created a platform that could be extended cost effectively to expanded public transport services.

The government and the mobile network operators in Nairobi have sought to encourage greater use of M-Pesa as a payment mechanism on *matatus*; but adoption appears to have been more limited than hoped.

The Kigali Tap and Go system has arguably met envisaged objectives, and is being broadened to incorporate new mobile phone-based technologies. The fee levied on the collections has been sufficient to sustain the system, and the fare collection company is seeking to expand its activities to other markets. This suggests a good cost-benefit outcome.

In Lagos, while card systems have functioned, they have struggled to attract a high proportion of riders, particularly the more recently introduced EMV-based FarePay system. Consequently, the Cowry system was initiated, which is a closed NFC card that is compulsory on the new Line 2 of the BRT, and appears to be working satisfactorily although it is somewhat early to make a definitive judgement. The relatively poor adoption and other shortcomings of the earlier schemes was useful in bringing LAMATA to its current approach of a closed, non-EMV NFC system with no cash option.

In Maputo, the system has not yet been implemented, so no assessment can be made.

The Chalo fare system appears to have the potential to be highly successful based on its strong growth since its first use as a tracking app for users in 2018; hence, its inclusion in this report. While Chalo benefited in its early years from substantial venture capital injections, it remains to be seen whether it can sustain profitability. Nevertheless, the kinds of innovation it is bringing to bear in the sector appear to augur well for its success.


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7. CONCLUDING OBSERVATIONS

The first part of this document sought to provide a conceptual framework as a backdrop for understanding the six case studies described and analyzed in the later chapters. A wide range of issues have been addressed. This chapter concludes the analysis with five high level sets of observations—each organized as a response to a question—consolidating and reiterating some of the most important themes that have emerged.

7.1 // Are automated fare systems worth it?

A general assumption prevails that automated fare systems are superior to cash-based systems and that modernization is the solution. However, when introducing new automated fare systems to replace cash systems it is important to be clear about the envisaged objectives.

The key arguments for the introduction of automated fare systems are:

- They can enable quicker boarding, improving journey times and efficiency of bus use.
- They can be helpful in curbing fare evasion, fraud and the scope for theft of cash from vehicles.
- Staff requirements for handling on-board cash payment are reduced.
- An automated system is a rich data source that can be used to improve services, better tailoring supply to demand.
- Transparency in cashflows can improve the bankability of transport projects.
- They are more convenient for the user.

These are strong arguments. However, automated fare systems can be costly when all the various cost elements are included, and the benefits may not always exceed the costs. Where margins are low, the additional cost of an automated fare may be challenging for a bus operator to bear.

User convenience is often cited as a reason for the introduction of an automated fare system, but is not always convincing. Cards or other fare medium devices need to be loaded with value, and this can sometimes be highly inconvenient; in a society where cash is commonly used, few substitutes are as convenient as cash. Moreover, it is assumed that users will load value for many journeys at a time. Because loading imposes costs on the fare collector, a loading fee is often applied, making it effectively more costly to load many small amounts. Yet, many users in Africa cannot afford advance payment for travel and have no option but to load little and often, adding to both inconvenience and cost.

In many systems, a conductor takes the cash during the journey; thus, the vehicle is not delayed by the driver issuing the ticket or finding change. In other instances, tickets or travel passes are bought off-bus, avoiding most of the challenges of on-board cash. The conductor also provides additional services such as a level of security or answering customer questions. The cost of this depends on applicable labor costs, which may be low.

Depending on its sophistication, the automated fare system may introduce rigidities into the system. Most of the systems examined in this study had flat fares per route, since this was all their technology could reasonably handle. Introducing more complex, distance-based fares requires tapping off the system on exit, a mechanism to calculate the fare based on the distance traveled, and an ability to complete the transaction on exit. A conductor can manage a more complex fare system than a flat fare, charging, for example, by number of stages, and being able to make judgements as to whether concessions being used are appropriate.

As the service increases in size, the arguments for an automated fare system become more compelling (Box 7-1). The generation of good data from the system is probably the most important benefit, so long as it is fully utilized to improve operations or serves to improve bankability. It follows that the introduction of an automated fare system should be part of a wider strategy of automation and digitization, where fare system information is used along with other data to run analyses and generate efficiencies, and improve financial transparency. Indeed, where this is not the case, the costs of introducing an automated fare system may be hard to justify.

In this study, it was not feasible to perform cost-benefit analyses of the various fare systems. What is clear is that, when introducing a new automated fare system, clarity about the objectives and realism about all the potential costs and benefits is needed.

KEY TAKEAWAYS

- Clarity about the objectives and realism about all the potential costs and benefits are essential when introducing a new automated fare system.
- Cash remains the most convenient medium for many users.
- The generation of data by the fare system is arguably the most important benefit, so long as the data is actually used to optimize the system and improve bankability.
- Fare systems are likely to add most value where the interests of the fare system owners are well aligned with improving the effectiveness of the transport business overall.

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Box 7-1
Key takeaways: Automated fare systems

7.2 // What are the most significant technological trends?

While fare payment in Africa remains largely cash based, electronic systems are being introduced mostly as card-based systems. The introduction of smartcards include the developments highlighted in Cape Town, Kigali, Lagos and Maputo. Repeated and thus far unsuccessful attempts have been made to introduce card-based systems in Nairobi, including a new attempt that emerged while this study was underway. However, Nairobi has seen a gravitation toward payment using mobile phones, driven in particular by the popularity of M-Pesa. Many of the card systems can be loaded using mobile money, such as M-Pesa or its equivalents.

The systems range from card-centric systems, such as the latest innovation in Lagos, to systems that tend toward account based, back-office systems such as the one being introduced in Maputo. The newly envisaged national system that is identified in, but not the focus of, the Cape Town case study is also predominantly an account-based, back office-centric system.

There are various approaches to opening fare systems. Cape Town's **my**connect card offers an unusual case where the card is an anonymous Europay, Mastercard, Visa (EMV) compliant bank card able to make small purchases at any EMV point-of-sale, while also containing a transport card data structure that enables it to function as a closed system. None of the systems studied has the equivalent capacity of Transport for London's facility to pay by credit or debit card, although the Cape Town system could easily be reconfigured to do so were national regulations to permit. Open systems are not yet common in Africa although some do exist, such as on the Gautrain in South Africa.

Most systems only require the user to tap when entering, with the validator being set to deduct a flat fare regardless of where the user disembarks—although in Kigali, for example, this is sometimes reduced along the route so that people boarding closer to the end of the route pay less. Cape Town's **my**connect is an automated system which charges according to distance traveled, requiring tapping both at boarding and alighting. Similarly, the Lagos BRT has a zonal fare requiring tapping on and off. In most systems, such as when paying using M-Pesa on Nairobi matatus, the user is told by the conductor how much to pay, or the flat fare is set on the validator, and access is controlled in person by a conductor or driver.

Mobile data phones, or smartphones, offer a much greater scope than card systems. While cards enable the digitization of transactions, making much better data available to the operator and helping to reduce leakage, the mobile phone offers the potential for a rich two-way flow of information between a user and the system. In coordination with a back office and other connectivity, the smartphone is potentially able to:

- Load a virtual card and thus function like a card within a card-based system.
- Generate an electronic ticket that can be read by a conductor or a QR code that can be read by a validator.
- Load credit conveniently from a mobile banking or equivalent app.
- Easily make a payment to a recipient having only a printed QR code.
- Be tracked at all times, if permitted, and not just at tap-on or tap-off.
- Offer system information, and trip and transfer choices to the user.
- Offer a booking service.
- Track and provide estimated times of arrival of vehicles and final destination.
- Provide information on the available passenger capacity of the arriving buses so users can decide whether to take the later bus.
- Integrate with face recognition or other systems for identification of user.
- Send out trip requests if the service is demand responsive.
- Automatically generate information on driver behavior.
- Be used by a customer to rate service provider performance.

Most mobile phones in Africa are feature phones, which have more limited functionality, although they support payment transactions using mobile money, such as M-Pesa. Nevertheless, smartphone penetration is growing fast. Some of the card-based systems, such as in Kigali, offer smartphone options, while SWVL in Nairobi, which is a booking and tracking service with a payment option, uses only smartphones.

Although not explored in the same depth as the African cases, the study examined the case of Chalo, which operates in 30 cities in India, and which began initially as a tracking service, expanding subsequently into payments and operational support to bus operators. When Chalo extended its services to fare payment, it introduced a closed-loop smartcard that it developed itself. It has a handheld device which prints tickets paid with cash, reads cards and can scan QR code based tickets generated on smartphones. This means that data generated from all types of transactions are consolidated within a single fare system, and can be used to optimize operations.

The mobile phone has the ability to bring new efficiencies to public transport across the full spectrum of services, although these will differ among services. Among mass transport services with fixed routes, such as rail services, its usefulness revolves mainly around improving transfers and journey planning, while for more flexible and demand responsive services it enables the development of new service offerings, where supply responds to demand potentially in real time. Across all services, it offers a convenient mechanism to pay (Box 7-2).

KEY TAKEAWAYS

- Mobile phones have the potential to offer much wider functionality than smartcards, communicating directly with the user, and are beginning to be used for fare payment in Africa.
- However, many users do not have suitable phones or are not comfortable using them as a device for automated fare payment systems other than making ordinary mobile money payments to the conductor as a substitute for cash; the majority of automated fare systems are card based.
- Initiatives are being taken to introduce back office-centric, account-based systems but these are not yet proven in the African environment.

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Box 7-2
Key takeaways: Significant technological trends

7.3 // Is implementing a new fare system primarily a technological challenge?

In the implementation of an automated fare system, attention is naturally drawn to the new technology. However, technological change is not just about the tools and machines, but how these are used in conjunction with changed business processes and organization. These, in turn, are nested within a set of institutional arrangements. Some would argue that there is a need to broaden the concept of technology from tools and machines to 'ways of doing things.'

A key issue is how revenue risk is allocated. Those bearing the most risk have the greatest incentive to ensure that the system works well. This, in turn influences how control over a fare system needs to be configured. But if a fare system service provider is paid based on the number of transactions, then it is fundamentally invested in overall ridership levels—a matter over which it may have limited control.

Table 4-1 summarized how revenue risk is configured under different sorts of arrangements. In most of the cases in this study, operators function under net contracts, for example, in Kigali, Lagos and Maputo. The bus company takes most of the revenue risk, and therefore needs to ensure not only that the fare is optimally collected at reasonable cost, but also that buses are as full as possible, maximizing revenue over costs.

In Cape Town, bus operators are employed by the municipality on a gross contracting basis. The intention was to consolidate responsibility for all road-based public transport contracts under the municipality, with the municipality running an integrated fare system across all services. However, despite national legislation being passed to do so, the consolidation of services at the municipal level has not yet happened.

The intention in Maputo is to introduce a common fare system across all services in the city, run by a private sector provider contracted by the municipality, and operating within a net contracting environment. One of the challenges it faces is the tension of having a fare system driven by the public authorities with bus operators contracted on a net basis.

The complexity of designing, implementing and running automated fare systems means that vehicle operators require new skills. Moreover, most bus companies cannot afford the up-front investment in the fare system and technology required to implement electronic fare payments. This is leading to the emergence of companies dedicated to implementing and running public transport fare systems, sometimes referred to as fare payment as a service (FPaaS). Such companies have the potential to develop well-honed business processes and appropriate technologies that provide a better and cheaper service than would otherwise be the case.

In Kigali, all three bus companies use the same independent fare collector, AC Group. This enables a single card to be used across all bus services in the City. This common provider model is strongly encouraged by the government, although not officially required by any contracting arrangements.

Key issues include the contracting arrangements and basis of remuneration that are established. In most cases, because of the up-front costs, the third party fare collection company makes the investments and charges the bus operator a fee per transaction. This is the case in Kigali and Maputo.

One of the more interesting features of the Chalo case, the Indian third-party fare system provider, lies in its business model. At the start of the arrangement, Chalo identifies the existing average revenue in partnership with the bus operator. Apart from a small daily fee for equipping each vehicle, Chalo then charges a share of revenue generated in excess of the average as a result of the improvements that Chalo has introduced. While arrangements differ in different cities, in many cases Chalo guarantees a minimum level of revenue, in effect, removing the revenue risk from the bus operator and transforming a net contract into a gross contract. This model incentivizes Chalo to improve bus services, and has led the company to become involved in various kinds of operational support, while also taking direct employment responsibility for the revenue collection crew.

The third party fare system provider is clearly an appropriate model under a variety of circumstances. However, this approach is still relatively new. One of the challenges is that, while the tools and equipment itself may be standard, the context within which it must operate may vary substantially, requiring flexibility and adaptability on the part of the FPaaS provider. At the same time, vehicle operators or transport authorities employing such service providers need to develop the skills to be able to manage them, allocating responsibilities, risks and rewards appropriately.

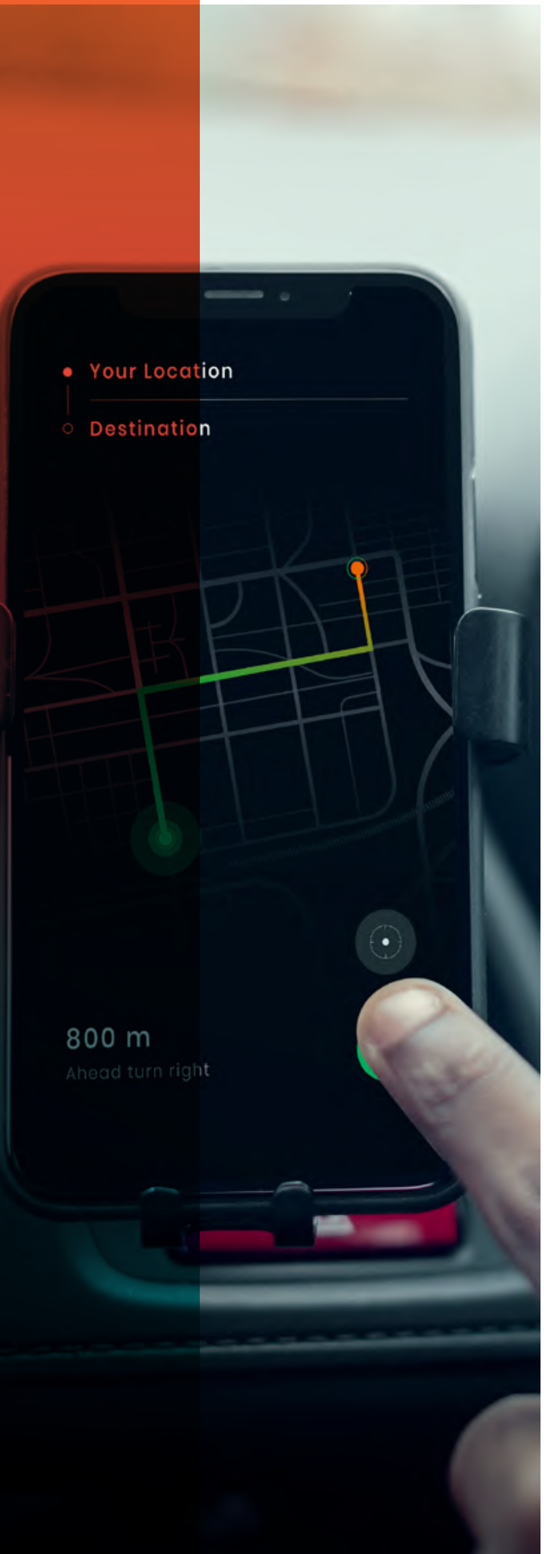
What is critical is to find ways whereby the interests of the fare system operator are aligned with the improvement and profitability of the transport service (Box 7-3).

How fare systems are organized is not just a technology issue or fare systems efficiency issue, but a fundamental element in how the institutions, incentives and power relations in the delivery of public transport are constructed. Indeed, a significant risk lies in initiatives to modernize fare systems failing to pay sufficient attention to these institutional dynamics.

KEY TAKEAWAYS

- Fare systems are a fundamental element in how transport operations work and affect incentive structures and power relations in the organization of public transport delivery.
- The implementation of new fare systems is, therefore, much more than a technological challenge.
- The design of the fare system must align with how revenue risk is configured.
- Fare systems are likely to add most value if relationships are structured so that the interests of the fare system owners are well aligned with improving the effectiveness of the transport business overall.

Box 7-3 //
Key takeaways:
Implementing fare systems



7.4 // Can paratransit systems be improved by introducing automated fare systems?

While significant financial resources and effort have been directed toward the formal public transport sector across Africa over the years, arguably not a single African city has a formal public transport sector that carries a higher number of passengers than the informal paratransit sector. The sustained success of the paratransit sector—which typically operates without any subsidies—is leading to increasing recognition of its importance, and greater awareness that transit strategies need to build on this success rather than replace it with more expensive formal solutions. Introducing electronic fare systems into paratransit is often seen as a key mechanism to do this; however, this has been largely unsuccessful. Some countries, such as South Africa, have experienced repeated unsuccessful attempts to introduce cashless fare systems in paratransit from as early as 1999.[1]

Initiatives to introduce automated fare systems in the paratransit sector usually come from vehicle owners or fare system implementers, or from public authorities seeking greater control. The challenge lies in the paratransit business model, which is usually based on the target approach, where the driver is, in essence, a small entrepreneur renting the vehicle from the owner for a daily fee, taking the revenue risk (see Table 4-1). Increased passenger loads translate into higher earnings for the driver; the owner cannot accurately know how much fare revenue has been earned. The shift to an automated fare system results in a redirection of the cash flow away from the driver to the owner, disempowering the driver.

While a range of incremental improvements are possible in the paratransit sector, the critical step in improving efficiency is when the collective fleet is able to respond to demand with an appropriate, data-driven service plan that maximizes average load factors. But this is not possible when each vehicle continues to earn on the basis of the number of passengers it carries itself. Fares need to be pooled to remove the perverse incentives that undermine collective efficiency.

In the context of a business model shift of this nature, the introduction of an automated fare system could be pivotal, not only in preventing the continuation of drivers taking the fare, but also in enabling transparency among all owners as to the total fare income earned collectively. A change to a more collective structure is a substantial organizational change, including a change in the structure of labour relations and how the driver is remunerated.

The introduction of an automated fare system can be an important element in a wider set of changes supporting a changed business model. But by itself, it does not change the business model. So long as the same business model continues, limited benefit can be had from the introduction of automated fare systems in the paratransit sector; and they are probably unlikely to work, predominantly because of driver or conductor resistance.

The use of M-Pesa to pay for fares on the Nairobi matatus is sometimes cited as a successful example of the implementation of electronic fare systems. But this innovation does not seek to change the business model. Payment is made to the account of the driver or conductor; merely a switch from cash to electronic form, with little change in the nature of the service.

Chalo works with many small operators, and has usually been more successful where they work closely and directly with the crew, often offering improved working conditions and income. A pilot project to formalize a group of paratransit companies described in the Cape Town study takes the same approach. However, there is little evidence of a wider implementation of this type of model. The operators Chalo works with in India tend to be more regulated than most paratransit in Africa.

Most attempts at introducing electronic fare systems in the paratransit sector fail because they fail to properly comprehend the significance of addressing the business model and the complexities of doing so. While the introduction of automated fare systems in the paratransit sector can be an important element in enhancing this sector, it needs to form part of a broader change strategy (Box 7-4).

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Box 7-4
Key takeaways: Improving paratransit systems

KEY TAKEAWAYS

- Paratransit is the most successful form of public transport in Africa, accounting for the majority of trips in almost all African cities.
- Significant improvement of paratransit requires changing the business model to enable collective rather than individualized management of the fleet while maintaining the drive toward serving passenger trip needs.
- Automated fare systems can be an enabler of the change but are likely to fail if not implemented in ways that address the power relations and incentive structures between drivers, operators and passengers.

7.5 // What role should government play in the automation of fare systems?

The role of government will differ in different contexts. One of the challenges in much of Sub-Saharan Africa is the limited institutional capacity of government, while levels of compliance with rules and regulations are comparatively low. Informality is the dominant mode, with paratransit accounting for the majority of public transit services in most cities in the region. This makes some of the practices that have been developed in industrialized countries difficult to apply. At the same time, significant differences exist within the region.

Private initiative is important, and in the African context, endeavors that do not build on the drive and entrepreneurialism of the private sector may have a limited chance of real success. But a supportive public sector is also critical.

The Kigali case, which is among the most successful of those studied, was initiated by a private company that successfully demonstrated its capabilities through a contract with one bus operator, and was thus able to extend its reach to all formal bus companies in Kigali. The public authority appears to have played an important role in this extension of scope, although without any formal relationship between the fare collection company and the public authority.

Having a single, city-level authority responsible for public transport with jurisdiction over the whole urban area seems to be a key element in developing appropriate public sector strategies for automated fare systems as, indeed, it is for managing urban public transport generally. Central governments often have the resources and political power to initiate significant new programs, and therefore can play a useful role, particularly in smaller countries that have a single core urban center needing an automated fare system. But they usually do not have the local focus and engagement with the complexities of mobility across the urban environment that a local, city-wide institution will have; and they can easily become motivated by extraneous concerns. This is evident, for example, in Nairobi, where repeated attempts, driven by national interests, to introduce card-based payments for public transport have failed.

The Cape Town case represents an interesting example of both the strengths and weaknesses of national government involvement. The myconnect system was based on ideas generated at the national level that Cape Town piloted with very substantial financial support from the national government. But the practical difficulties of implementing the scheme, based on the transport card also being a Europay, Mastercard, Visa (EMV) low value payment bankcard, led the local municipality to significantly refashion the way the card effectively functioned. Implementation on a reconfigured basis was successful, but the municipality subsequently battled unsuccessfully to change national regulations that would have significantly improved the system, including the acceptance of debit and credit cards as a fare medium which, because of their EMV compliance, would have been easy to do.

In most of the case studies examined, some form of city-level transport authority exists. The creation of LAMATA in Lagos approximately two decades ago was an important advance in that city. The creation of the metropolitan transit authority in Maputo in recent years has precisely been the instrument that has enabled systematic new public transport initiatives, including the initiative to implement a new automated fare system. The municipality of Cape Town is a metropolitan wide body with constitutional responsibility for public transport, although the consolidation of responsibility for all modes at the city level has not yet taken place. An important objective of the MyCiTi project was to do this, and national support for the fare system was partly motivated by the expectation that the system would be extended to all modes in the city. The Nairobi Metropolitan Transport Authority (NaMATA) has recently been established in the Kenyan capital, but it is too early for significant progress to have been made. Moreover, changes to Kenya's city governance structures over recent years have left many institutions in a state of flux. Nevertheless, this institutional innovation should help in developing a more consolidated approach in Nairobi.

Because many of the cases are in capital cities, the distinction between central and city authority can be blurred. This appears to be the case in Kigali where the national authority is dominant, even if it acted in a fairly hands-off way and in conjunction with the city-level authority.

Given a constrained ability to direct public transport outcomes compared with cities in richer countries, city-level authorities in Sub-Saharan Africa ought to seek opportunities to engage strategically in ways that facilitate the emergence of positive outcomes—with the appropriate backing of central governments. They need to steer more than row, finding ways of stimulating and responding positively to private initiative.

City-level authorities must appreciate that they are often not well placed to understand how fare systems are embedded as an integral part of the bus business. They need to resist imposing technological solutions from outside, and instead find ways of responding to bus operator needs.

Acting strategically in this way requires significant skills, particularly in understanding how to regulate within an environment that does not usually adhere to regulations, how to apply limited resources in ways that bring substantial returns, and how to work with private sector operators, including the informal sector, in optimizing the public good (Box 7-5).

KEY TAKEAWAYS

- The national or central government often has the resources and political power to initiate significant new programs, but may not be well placed to understand the complexities of running public transport, and be easily motivated by extraneous concerns. While exceptions exist, national or central governments should play a broadly supportive role rather than get involved in system design and detail.
- City-wide municipalities or transport authorities, which are key to the success of public transport systems in general, can play a critical role in facilitating the implementation of fare systems that are aligned with wider systems underpinning their success.
- A key challenge for such authorities in supporting effective fare systems lies in aligning the creativity and competitive drive of private interests with the city-wide public benefit, based on multiple modes and focused strongly on the public transport user.

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Box 7-5
Key takeaways: Role of the Government

Notes

1. At least six serious attempts have been documented.


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