# Contactless Payments and Open-Loop Ticketing

What does this mean for transit authorities, and is there a business case for adoption?

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## Contents



## Overview

The use of contactless payments in retail environments has risen significantly in the last few years, with around 80% of all Mastercard credit and debit transactions under AUD$100 in Australia now made using a contactless bank card or mobile phone. The convenience contactless payments offer has made consumers' lives simpler and spurred high adoption. The benefits for merchants are clear: faster checkout times, happier customers, higher throughput and greater efficiency, resulting in increased revenue and reduced costs. Applying contactless technology to transit ticketing is a natural progression. It is a quicker, safer and more convenient method of collecting fares from customers, and reduces operating costs for transit authorities.

EMV (Europay, Mastercard and Visa) technology has been proven to reduce counterfeit card fraud around the world and is the underlying technology enabling secure contactless transactions across bank cards and mobile wallets alike.

With over 10 completed contactless ticketing or open-loop transit projects delivered around the world, and numerous other deployments in progress, transit authorities are recognising that applying payment technology to ticketing and fare collection can improve the customer experience, create efficiencies and reduce operating costs.

The opportunity to improve the customer experience, increase convenience, reduce or eliminate queuing time and reduce the overall cost of fare collection (COFC) are benefits that appeal to all transit authorities.

**Figure 1: Open loop transit fare collection projects**

# Executive summary

Today there are over 300 separate transit smart card systems in place across the globe. Out of the world's top 20 public transit networks by ridership, only Cairo's does not currently have a similar system in place.

Smart cards let customers load funds onto a transit card before travel, however value can only be spent accessing one specific network of transit services and there is a lack of interoperability across cities. Consequently, these systems are referred to as closed-loop.

An alternative approach that does not involve pre-loading or locking funds onto one particular transit network or city-specific transit system is called pay-as-you-go (PAYG) open-loop. In a PAYG open-loop system, transit fare payments are made via contactless payment cards or enabled mobile devices. Because they use existing payment technology, open-loop systems are globally interoperable. Customers can access transit services using their preferred contactless payment method, manage their funds with their preferred bank and enjoy added convenience, avoiding queues and the need to find a retailer or ticket office to acquire or top up a smart card.

There is a significant opportunity to leverage existing, globally accepted payment innovation and apply it to transit ticketing. By using mature and secure banking payment technology, transit authorities can remove themselves from the micro-payments business and reduce their COFC.

With numerous open-loop projects already delivered and live across the globe, there is ample evidence to show that applying contactless payment technology to transit fare collection can offer increased convenience to customers along with operational efficiencies and cost savings for transit authorities.

Inspired by such experiences, many cities have already approved business cases for open-loop contactless payments and are on their way to transforming their transit services.

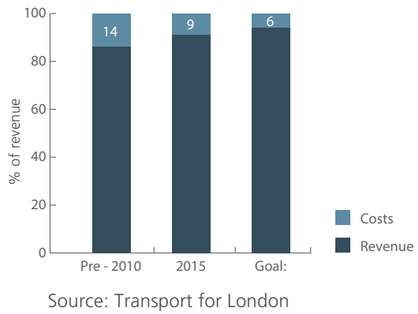
With Apple Pay, Samsung Pay and Android Pay all using the same underlying contactless payment technology, the business case for open-loop transit ticketing is strong and many innovative cities are choosing to use it. This is creating increased customer satisfaction and allowing transit authorities to focus their time and resources on delivering better services.

## Open-loop payments in London

Transport for London (TfL) has had a live contactless payment system on buses since 2012, and across Tube and Overground rail services since 2014. [1] On average, 7.7 million journeys each week are now made using contactless payments, accounting for more than 30% of all trips on the Tube and commuter rail system, and around 30% on buses. Benefits to customers, visitors and the city itself have been significant.

TfL's adoption of contactless payments has enabled many initiatives leading the COFC to drop from around 14% of revenues to just below 9%, and there are expectations that this will fall further to around 6%. [2]

**Figure 2: TfL's cost of fare collection**




Source: Transport for London

The project has been an unqualified success for TfL and has seen consumers eagerly embrace the technology.

**Figure 3: London's benefits at a glance**

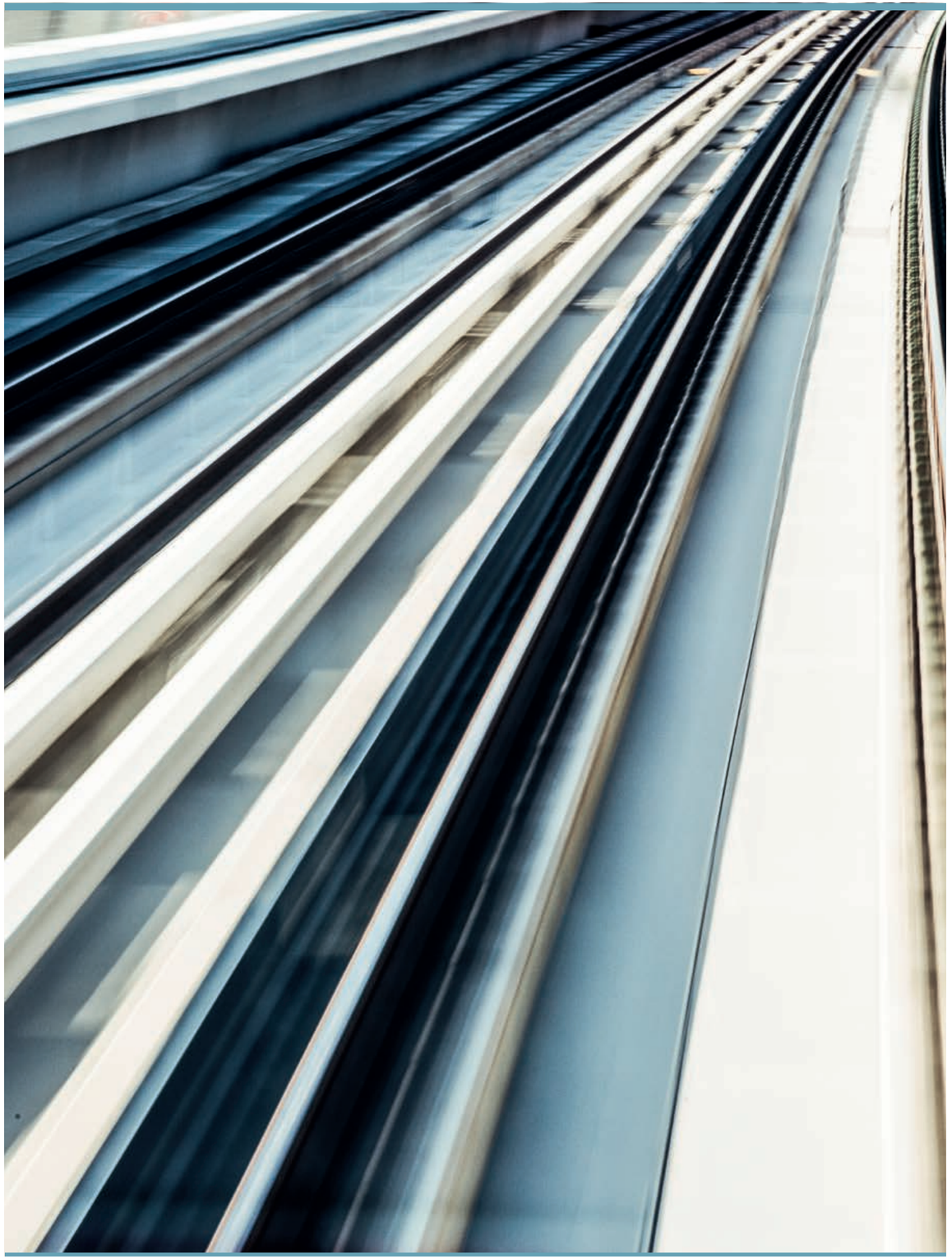
***Consumers*** *– be they London residents or visitors – indicate they prefer contactless payment because of its convenience. The most time-consuming and frustrating aspects of TfL transit has been eliminated, especially the need to pre-register or pre-purchase a "special" transit card before travel. Using their existing payment cards or mobile payment solutions has simplified each TfL journey.*

***Transport for London -*** *contactless has generated a reputation boost. The convenience and simplicity of the system has encouraged more individuals to use TfL rather than other travel options, while raising user satisfaction scores in the process.*

## Benefits of an open-loop system with contactless payments

Applying payment technology to transit networks and enabling open-loop acceptance removes transit authorities from the micropay-ments business, allowing them to focus on urban mobility services and providing customers with a more convenient travel experience.

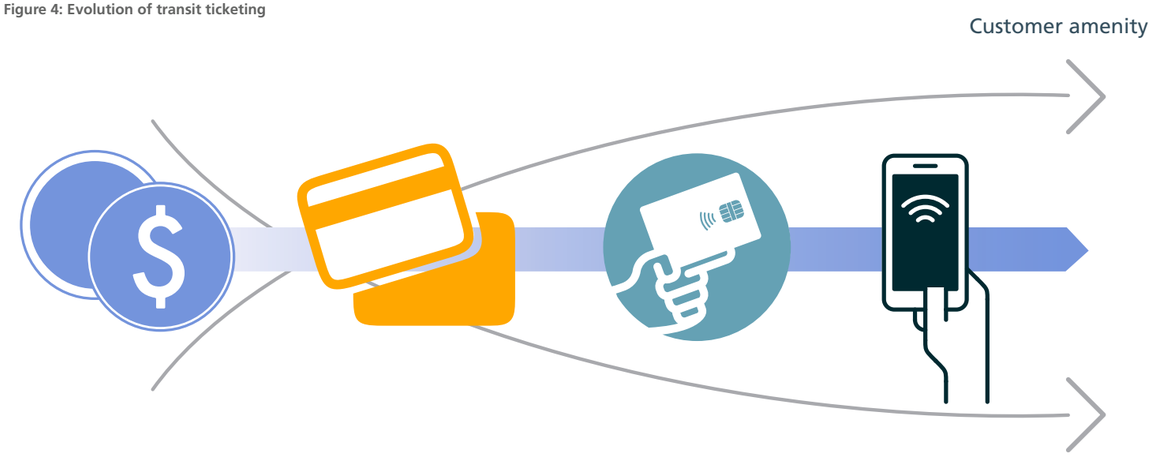
The history of ticketing media and payment channels has been characterised by increasing customer amenity and decreasing COFC. Open-loop payment is the logical next step.





This paper assesses the benefits and costs of implementing open-loop payment systems for transit authorities. In particular, the benefits of this technology are compared to those delivered by proprietary closed-loop smart card systems. It is argued that moving to an open-loop system and accepting contactless payments and ticketing gives transit authorities the opportunity to both decrease the COFC and improve the customer experience by offering a seamless means of accessing transit, bringing the payment experience for transit in line with customer expectations in the 21st century.

**Figure 4: Evolution of transit ticketing**




Since the introduction of the Korean Upass card in 1996, [3], and the Hong Kong Octopus card in 1997, [4] smart cards have become commonplace in many cities. Of the top 20 transit networks by ridership globally, only one, Cairo, [5] does not currently have a smart card system in place.

Closed-loop transit smart cards typically enable customers to load value either directly onto the card as stored value or onto an account that is electronically linked to the card. This value can then be used to pay for travel across a city's transit network; the fare is deducted from the card or account after completing a journey. In the majority of cases, the value can only be spent on a specific city's network of transit services, and consequently, these systems are typically referred to as closed-loop.

The success of smart cards, and their high level of adoption across transit systems globally, can be attributed to the benefits they provide to transit authorities and customers relative to other fare collection options. For transit authorities, smart cards reduce customer reliance on cash, which is expensive to collect and process. For people who frequent a particular city's transit system, smart cards reduce time spent queuing at stations buying tickets, and are relatively simple to use.

However, closed-loop systems have also introduced additional costs for transit authorities and still require significant customer interaction. Some drawbacks include:

### For transit authorities

- Cost of smart card production and distribution
- Cost of payment channel infrastructure (e.g. ticket-office staff cost, retail commissions, vending-machine maintenance)
- Generally, 100% of automated fare collection (AFC) system upgrades are funded by transit authorities
- Lack of smart card interoperability across cities

### For transit customers

- The inconvenience of smart card acquisition and pre-registration (the need to order online or find a retailer to purchase and then register)
- Time spent queuing at a ticket office or retailer to top up value before travel
- Lack of interoperability across locations: visitors must acquaint themselves with specific city systems
- Funds can be tied up by loading more monetary value than needed for a single journey, and this money is wasted when visitors travel home
- Funds can be lost if the smart card is not registered with the transit authority, letting the user freeze the card if it is misplaced or lost

In recent years, due in part to the take-up of contactless payments and near-field communication (NFC) technology [6], transit authorities have become increasingly interested in open-loop systems to either replace or complement existing smart card offerings. Authorities in jurisdictions such as Utah, [7] London, [8] and Chicago [9] have led the way in adopting these technologies.

Open-loop systems let transit customers pay for their travel using contactless enabled bank cards, mobile phones, or other NFC devices that are widely accepted as a means of payment outside the transit network. They offer a series of benefits to transit authorities and customers beyond those realised by closed-loop smart card based ticketing.

For transit authorities, adopting smart cards involves them directly in issuing and maintaining the cards, storing balances and clearing and settling transactions for their customers. By introducing closed-loop systems, transit authorities have inadvertently adopted functions more commonly associated with retail banks, without necessarily achieving the scale required to deliver those functions with the same efficiency as banks.

From a customer's perspective, the proposition of a stored-value smart card is at odds with expectations formed by monetary transactions. There are few other arrangements where a customer, to achieve the best value for money in buying a commonly used product or service, must pre-pay for something they may not consume in its entirety or for some time.

## Open-loop ticketing benefits to transit authorities

Implementing an open-loop system and accepting contactless payments as a ticketing medium is likely to reduce the COFC significantly and, by delivering tangible time savings and convenience to customers, encourage additional use of the transit network. Furthermore, interoperability across transit operators and services is automatically achieved for anyone using cards or mobile devices enabled for contactless payment.

### Effect on the cost of revenue collection

The magnitude of benefits realised in relation to the COFC will depend on factors including:

- The extent to which the stated benefits have or have not been delivered through other initiatives
- The effective retirement of legacy systems

Transit authorities with proprietary smart card systems are required to spend time and money on producing, distributing and maintaining a fleet of smart cards.

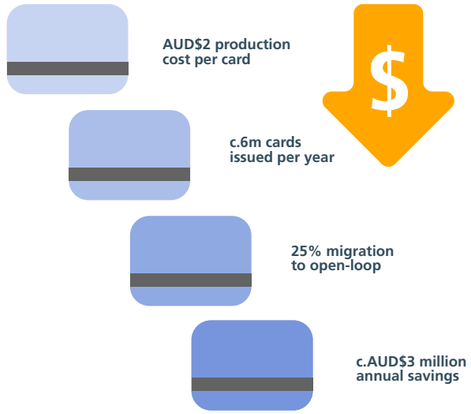
These are costly activities:

- Transit authorities typically pay between AUD$1 and AUD$2 to manufacture proprietary smart cards. [10]
- Additional costs are then incurred in distributing these cards to customers
- Smart cards typically have a high rate of churn, particularly in cities with high rates of travel by non-residents, including tourists, or with complex concession programs requiring frequent changes to cards for a single customer. For instance, from 2011–13, TfL issued over 6 million cards per year–more than 30% of the total number of active cards used on their system in each year. [11]

Implementing an open-loop system and facilitating acceptance of contactless payments externalises the cost of these activities to retail banking institutions, which have the scale and expertise to deliver them efficiently.



It is estimated that if a public transport agency similar in size to London's were able to migrate 25% of its smart card churn to contactless payments, it could achieve cost savings of more than AUD$3 million per year simply by avoiding the cost of card manufacturing.




Production of supporting collateral along with mailing and distribution costs of those smart cards can easily range from AUD$1–10 per card, depending on whether the card is distributed through a retail outlet or posted from a call centre. Taking a conservative view, where 10% of new cards are distributed by mail from a call centre, replacing smart cards with contactless payments would yield a further estimated saving of around AUD$1.5 million.

### Reduced use of higher cost payment channels

Giving transit customers a way to top up their smart cards typically adds significantly to the COFC for transit authorities. Common payment channels include:

- Auto-top-up. A customer's smart card is linked to a payment source that automatically tops up the value of a card or account after reaching a threshold value
- Web-based top-up. Customer-initiated top-up of a smart card using an online tool provided by the transit authority
- Self service machine top-up. Customers can top up their smart card using a self-service machine, typically found at a station
- Retail network top-up. Transit authorities frequently have arrangements with local and regional retail stores, where the stores provide the ability to top up a customer's smart card in exchange for a commission tied to the value of the top-up
- On-system top-up. Customers can top up their smart card by paying at a ticket office or customer contact centre, or in some cases on a vehicle (e.g. a bus)

Other than auto and web based top-up, each of these payment channels represents a significant cost to the transit authority, as they tend to be labour intensive. Self service machines cost money to install, maintain and empty. Ticket offices and customer contact centres are similarly expensive, requiring significant staffing expenditures. Where customers can top up their smart cards on the system (e.g. on a bus), it inevitably increases dwell times and can compromise on-time running.

Retail payment channels defer responsibility for cash collection and processing to a third party, but the commission made to the retailer for top-ups is typically around 2%–5% [11,12,13] of the transaction value, which can significantly affect the overall COFC.

Auto-top-up, in contrast, is a very efficient means of collecting revenue from smart card customers. It requires very little effort on the part of the transit authority, and average transaction values tend to be high, decreasing the relative importance of flat rate banking charges levied on a per-top-up basis. However, transit authorities have typically struggled to achieve high levels of auto-top-up adoption among their customer bases. For instance, in London in 2009, long after the introduction of Oyster, only 7% [14] of Oyster customers were registered for auto-top-up, despite the obvious convenience benefits. This is likely a result of:

- Lack of awareness that there are online top-up facilities
- A customer's sense that they will lack control over their funds
- Lower utility for infrequent customers, who may be more sensitive to "locking up" funds
- Perceptions that the set-up process is overly complicated

An open-loop system and contactless payments address a number of these key concerns. Customers pay for travel when they consume it and not before, so they are not forced to lock value onto a smart card and do not perceive a loss of control over their funds. In addition, as they simply use the payment card or a contactless payment enabled device they already own, there is no need for separate pre-registration.

Consequently, open-loop systems provide a way to migrate customers away from more-expensive payment channels, such as retail outlets, self-service machines, and ticket offices.

### Reducing "cash on system"

Processing cash represents a significant cost to transit authorities. Cash must be collected and processed physically, so accepting it is significantly more labour intensive than taking electronic payments of any kind. Accordingly, minimising the amount of "cash on system"—the proportion of fares paid for with cash—is beneficial to transit authorities.

In 2006, a large American transit authority reported that the costs of cash collection represented 22.5% of the value of the farebox revenue collected. [15]

Migrating customers from smart cards to contactless payments represents an opportunity to further reduce the amount of cash in the system and the associated costs of collection.

### Closure of ticket offices and removal of self-service ticket machines

By providing customers with an additional payment channel for transit, it becomes possible for transit authorities to close down or significantly reduce the number of ticket offices and self service machines, both of which represent a significant cost to transit authorities, especially as installed equipment ages. In Budapest, for instance, the Centre for Budapest Transport (BKK) reported that the cost of revenue collection using their ticket vending machines was in excess of 50% of the sales made through that channel in both 2010 and 2011. [16]

### Driving additional usage

Acceptance of contactless payments is likely to drive additional usage of transit networks, because it:

- Adds an additional way for customers to pay for and access transit, increasing the addressable pool of customers by further reducing ticketing as a barrier to transit use
- Generates time savings and convenience for customers, relative to smart cards and other ticketing media

Considering the time savings delivered by contactless payments, due to the removal of the requirement to acquire and top up cards, additional patronage of approximately 1% could be expected for a system migrating from closed-loop to open-loop automated fare collection. This is further explored below in the "Customer Benefits" section, where the economic value of the time savings realised is estimated.

For systems introducing open-loop fare collection in greenfield sites, the customer time savings associated with the ticketing function, and consequently the increase in patronage, could be more significant.

### Increase commercial opportunities

Transit authorities that have implemented contactless payment technology have been able to increase revenues by releasing further space in stations for commercial tenants and retailers.

Transit authorities have also benefited from partnerships and collaborations with technology companies like Mastercard for promotions such as "Fare Free Friday" and "Fare Free Monday", where Mastercard offered cardholders free travel using their contactless Mastercard. [17]

### Improved fare-product management

With the advent of open-loop and account-based ticketing, transit authorities have been able to move fare collection systems from field devices to a central back office. This centralisation allows transit authorities to make changes to fare product offerings quickly and efficiently, relative to systems where each field device would otherwise need to be updated individually.

Introducing open-loop contactless payments in a PAYG environment can also reduce the need to provide single ride tickets for infrequent users or tourists. With PAYG, the customer gets charged the best fare at the end of the aggregation cycle (normally each day), and does not have to worry about seeking a refund for unused funds if they stop using services provided by the transit authority.

### Reduced back-office security costs

Open-loop systems position transit authorities well for further COFC savings through the adoption of back office banking software that manages funding accounts and security. This allows transit authorities to benefit from the significant investment made by the banking and financial technology sector in technologies and standards that increase security and reduce fraud.

### Shifting liability from transit authorities to banks

The adoption of open-loop systems also brings advantages that come with certain payment schemes. For example, Mastercard has global rules in place that provide the transit merchant with AUD$35 (in Australia and New Zealand) of chargeback protection for up to 14 days, providing there is a nominal authorisation (AUD$0.10) approved by the issuing bank. [18] This means that even if a customer only has AUD$1 of remaining credit limit or in their bank account, and the aggregated fare for that day's travel is AUD$15, the transport authority is guaranteed payment of the AUD$15. For smart card schemes that let the card balance go negative, this can represent a significant transfer of liability.

### Reduced cost of keeping technology current

In the past, transit authorities have found themselves locked into 10–15 year contracts, often for technology that becomes obsolete during the contract lifecycle. With the adoption of contactless payments for transit ticketing, authorities get the opportunity to be pulled along with the banking and payments sector rather than being left behind. For example, once a transit authority accepts contactless EMV bank cards, they can instantly benefit from innovations that run on the same EMV standard. Apple Pay and Android Pay, as well as most of the bank-owned digital wallets, both run on contactless EMV technology, and transit authorities can benefit from this without having to invest in or develop their own mobile payment systems. [19]

### Customer benefits

Adopting contactless technology as a payment channel and ticketing medium is likely to give customers tangible time savings with material economic value, while improving convenience, accessibility and security.

### Where do customers save their time?

Customers who migrate from smart cards to contactless transit payments are likely to save time by avoiding activities such as:

- Acquiring and pre-registering a smart card for any location they frequent or travel to
- Queuing to top up funds for their smart card
- Understanding the specific smart card ticketing systems of different transit authorities when they travel to other cities

Although the time taken for a customer to complete a transaction to top up their smart card is relatively modest, in most cases they must either be in a transit environment to access a ticket machine or find a merchant that has top-up facilities. Such retailers are not always conveniently located next to bus stops and other transit services.



### Convenience

Contactless payments offer a convenience factor beyond that presented by using closed-loop smart cards. Customers can simply turn up, tap and travel with the payment method already in their possession, be it a contactless bank card or mobile device.

Transit customers that use contactless payments are not required to tie up funds on a stored-value product before accessing transit, as is the case in closed-loop systems. Customers can pay for transit as and when they consume it, with no guesswork required before travelling.

Customers also do not need additional wallet space for a transit smart card for every destination they frequent or travel to, as open-loop ticketing, like the contactless payment systems that facilitate it, is by nature globally interoperable.

*The aggregate value of customers' time savings is substantial. For a transit operator with c.100m trips made per year, achieving 50% uptake of open-loop contactless payments would unlock time savings of c.0.5 million hours for the customer base, with an economic value of between AUD$5 million and AUD$10 million dollars per year, even accounting for the fact that smart cards do not need to be topped up after each completed journey.*

### Accessibility

Adding contactless technology to the available payment channels increases the number of ways customers can access transit, improving accessibility. Its convenience is particularly relevant for infrequent users of particular transit networks, such as tourists and other international and domestic travellers, for whom the barrier to use transit, due to lack of convenient acquisition channels and understanding of separate ticketing systems, is often relatively high.

If an open-loop system is in place, visitors can arrive in a city and travel immediately using their contactless payment method without first having to understand what the local transit smart card is called, where to buy it and how to use it.

### Security

Customers benefit from the significant investment that the banking sector has made in the security of contactless technology. The advanced cryptography requirements in EMV standards involve mutual authentication between contactless cards and terminals and have thereby greatly reduced the incidence of counterfeit card fraud in EMV payments markets. [20]

Customers also have less need to carry cash, improving personal security.

### Interactions with the banking sector

Implementing an open-loop system involves a change in the typical interaction between transit authorities, acquiring banks and the issuing banks of customers.

### "First ride risk"

The traditional model of online card authorisation for retail payments requires the merchant to get electronic authorisation for payment before supplying the goods or services. This model can work in a transit environment that has extremely reliable communications and low patronage, but it does not lend itself well to high volume operations where customer flow is critical. At busy stations, for example, where it is necessary to move high volumes of customers through gates at times of peak usage, transit authorities have to trade off the ability to accept the card and grant access instantly against the risk that they will not be able to capture the fare at a later point in time. If the cardholder does not have sufficient funds in their account to cover the fare (or in the case of Mastercard, a nominal authorisation of AUD$0.10), the operator is exposed to a small debt, termed "first ride risk".

Most cardholders quickly return their bank account to good health, and at such time the transit authority can reclaim the money through automated debt recovery processes, resulting in exposure of less than 0.4% of farebox revenue. This is arguably less than the potential loss associated with negative closed-loop smart card balances. Some jurisdictions have been able to negotiate sharing this exposure with issuing banks to some degree. However, data has shown that the risk associated with customers with insufficient funds using a contactless EMV payment method is tiny.

### Call centre interactions

In an open-loop scenario, the customer's first port of call to see what fare has been charged to their account is their bank statement or their bank's call centre. For transit authorities, open-loop systems may then mean lower customer call centre volumes related to transaction value queries.

## Open-loop, cost of implementation

As with any business case, it is important to start with an understanding of the current cost incurred by a public transport authority in collecting farebox revenue.

# Analysis of cost of fare collection

COFC analysis illuminates how the cost of collecting fares builds up to be a material fraction of a transit authority's cost base, but one which is difficult to track, as it generally consists of components in budgets distributed across the entire business.

To assess COFC, visibility of annual farebox revenue and the costs of collection for a full year is required. For the purposes of analysis, we can assess COFC by considering a hypothetical situation where a transit authority offers free travel but carries exactly the same patronage. This last condition is important, as it allows us to ignore the price elasticity of demand in the analysis. The analysis is then performed by systematically identifying all (avoided) costs that are at all associated with collecting and processing fares and with assisting customers in paying fares. The sum total of these costs is the COFC, but COFC can also be expressed as a fraction of the fares paid by customers in the real world.

To get more insight out of this analysis it is helpful to divide the costs that make up COFC into the following categories - see Table 1.

Within each of these categories, it is important to further divide the costs into operating expenses and capital investment. Where significant sums are invested in the capital stock of a transit authority's infrastructure in a given year, the COFC calculation can be severely distorted.

**Table 1. Cost categories making up the cost of fare collection COFC**

| Category | Definition | Example categories of spend |
|---|---|---|
| Infrastructure and management  | The cost of providing ticketing infrastructure, including retail channels, acceptance points and all the associated networks, data processing, suppliers and cash-handling facilities. Management and administrative overhead for ticketing infrastructure is also included.<br>These are primarily fixed costs, but some long-cycle variable costs sit here too. | • Gate-line maintenance<br>• Debt service on capital costs<br>• Access to wide area networks (WANs)<br>• Secure cash storage facilities in stations<br>• Cash transportation service contracts<br>• Back office software licenses<br>• Contract managers<br>• Performance analysts |
| Product sales  | The incremental costs incurred by the business in selling individual products to customers, including commissions, staff time, data transfer costs and transaction processing fees.<br>These are primarily marginal costs of goods sold, although some short-cycle variable costs sit here. | • Ticket office and bus driver staff time spent on completing transactions<br>• TVM operating expenses<br>• E-commerce site costs<br>• Commissions to third-party retail outlets<br>• Merchant service fees<br>• Cash handling fees<br>• Opportunity cost of rent foregone for in-station retail |
| Revenue protection  | The costs of a revenue protection force, including providing them with the tools and processes they need to do their work, and of other staff that act as a deterrent to ticketless travel.<br>This is assessed as a gross cost, though it is possible to offset it with income from penalties. It is important to think through the logic of doing so carefully.<br>These are primarily fixed costs, but some long-cycle variable costs sit here too. | • Full-time revenue protection staff<br>• Hand held devices for inspectors and associated data processing systems and contracts<br>• Fraction of station staff time spent on deterring or dealing with ticketless travel |
| Customer information and service  | The cost of informing customers about the specifics of the city's ticketing system and of resolving difficulties that customers experience in using it.<br>These costs are of mixed type. | • Information posters<br>• Ticketing information website<br>• Ticket office, bus driver and station staff time spent on educating customers<br>• Call centre agents<br>• Call centre systems<br>• Costs of chargebacks and refunds |
| Smart card production and distribution  | The costs of giving customers a contactless device on which to carry the travel products sold by the city authority. | • Card procurement<br>• Card configuration<br>• Card artwork<br>• Card distribution to stations and mail ful-filment centres<br>• Mail fulfilment<br>• Card security<br>• Station staff time spent issuing cards to customers |

# The effect of open-loop systems on transaction costs

## London's experience

Considered as a fraction of TfL's estimated £3.5 billion farebox revenue [21], COFC was around 14% in 2006 and has since fallen to closer to 9%, mainly because of the effect of inflation on the ticket prices and increasing transit patronage being serviced by a ticketing infrastructure that has managed to meet demand without needing incremental expansions in scale.

Considered across the five categories from Table 1, London's estimated costs originally had the following distribution.

**Figure 5: Components of Transport for London COFC, by category***


*Percentages represent fraction of COFC

Source: Transport for London

On identifying this distribution, the business case to reduce these was founded upon reducing product sales and smart card production and distribution costs.

There are now more than 10 jurisdictions worldwide that have completed and delivered open-loop transport ticketing projects, and in excess of a dozen more that have completed a business case, thereby establishing that an open-loop system will deliver significant benefits, and have commenced a trial or initiated a procurement process.

## Capital expenditure

Capital expenditure associated with implementing an open-loop system varies significantly by jurisdiction, with reported contract wins varying from c.AUD$2 million to AUD$100 million.

The capital expenditure for introducing contactless payments and ticketing depends on factors including

- The technological infrastructure in place across the transit network before deployment
- The scale of implementation required across the network

However, as EMV reader technology is becoming commoditised and more vendors are offering EMV-compliant readers and back office software, there is now a truly competitive landscape that is driving costs for transit authorities down.

Further detail on recent contract wins in the industry can be seen in appendix 1.

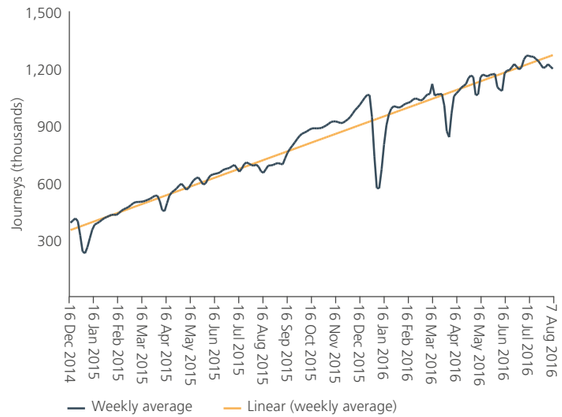
## Operating expenditure

Operating expenditure associated with implementing open-loop systems based on contactless payments varies depending on project scope (scale of implementation and network size), the environment in which the system is implemented, and the fare policy settings chosen (which significantly affects the rate of adoption).

In places that have introduced a fare policy where contactless payments are only accepted in place of a single ride ticket or at a premium to other ticketing options (e.g. Chicago), adoption has been low. However, in some places (e.g. London), smarter daily or weekly fare calculations have made the open-loop offering the same price as, or in some cases cheaper than, other ticketing options. Under such conditions, adoption has been high and has allowed the jurisdiction to realise significant operating expenditure savings.

The difference can be very clearly demonstrated by the experience of TfL, where in the initial pilot stages there was a "retail-like" flat-fare contactless payment option, only available on buses. However, in 2014, when TfL expanded use across its entire network, introducing daily and weekly capping and fare parity, adoption grew rapidly. [8]

**Figure 6: Daily journeys using contactless in London**




Source: Transport for London - CPC Usage Data 2016

## The effect of open-loop systems on transaction costs

Operators looking towards an open-loop system could be concerned about the likely impact of bank related transaction costs.

While bank merchant service fees (MSFs) do vary significantly depending on the relationship between the merchant and acquiring bank, MSFs generally follow one of two models when simplified:

**Model 1.** The bank MSF is made up of a flat fee and a percentage of the gross transaction value.

**Model 2.** The bank MSF is simply a percentage of the gross transaction value.



Accordingly, the bank MSF fee model, the frequency of transactions and the volume of take-up are all important in calculating the impact of transaction costs. There are ways to minimise transaction fees, which depend on fare policy settings and the choices of the transit authority.

In an aggregated PAYG transaction model where the transit authority chooses to aggregate a number of taps or trips and then charges the fare (to which a discount may be applied) at the end of a day or week, the transaction frequency for an open-loop system can be different to a weekly closed-loop top-up, and transaction costs may differ if the MSF follows Model 1.

For example, if the transit authority chooses to go with daily settlement, the frequency of transactions that incur a bank fee for travel using an open-loop system will be more than in the closed-loop scenario where a customer performs a weekly transaction, at a higher value, using auto top up. Thus bank fees in Model 1 would be higher for open-loop systems than for closed-loop ones, as open-loop customers will tend to be making more low-value transactions while incurring multiple flat fees. The simple way to negate this is to negotiate an MSF that follows Model 2 above.

However, not all banks will be prepared to negotiate a "percentage only" MSF and so it is important that business case models assess multiple scenarios, including the following factors, which could help to optimise bank MSFs:

- Some schemes, such as Mastercard's, have accommodated "microtransaction" categories within their rules (which define payment arrangements between banks when a transaction is made, and represent default transaction fees charged to the merchant). While debit card transaction interchange rates can typically be around AUD$0.03–0.07 per transaction, the "microtransaction" rate – applicable to all transactions lower than AUD$15 in value, is only AUD$0.004. [22]
- Aggregating fares into a single daily settlement, or even a weekly charge, rather than settling after each journey, effectively increases the average transaction value, decreases the number of transactions and avoids the multiple flat-fee components associated with MSF Model 1 above.

## Does it add up?

When we compare the variable bank-related costs of fare collection for open and closed-loop ticketing systems (assuming a channel mix for closed-loop systems), we can show that migrating customers from smart cards that are topped up at retailers or TVM's that take cash, to contactless payment methods will allow transit authorities to realise significant reductions in the COFC under both MSF Models 1 and 2.

Figure 7: Comparison of variable bank-related COFC

| | Closed-loop | MSF Model 1 | MSF Model 2 |
|---|---|---|---|
| Contactless Market Share | 0% | 20% | 20% |
| Farebox Revenue | AUD$100.00 | AUD$100.00 | AUD$100.00 |
| Variable bank-related costs | AUD$3.40 | AUD$3.20 | AUD$3.00 |
| Variable bank-related costs % | 3.40% | 3.20% | 3.00% |
| Variable bank-related costs reduction % | | 6.25% | 13.33% |

**See appendix 2 for detailed assumptions.**

Source: L.E.K. Consulting estimates

At a more holistic level, the initial London business case prepared as part of TfL's Future Ticketing Project (FTP) highlighted strong potential returns. Specifically, the initial business case suggested that the FTP would be financially positive after 12 years and produce a benefit–cost ratio of at least 2:1. Key drivers of this business case reflected the issues outlined above. Specifically, cost savings were associated with reduced retail commissions, avoided Oyster card issuance costs and increased farebox revenue. From an economic perspective, delivering an improved customer experience and associated time savings was a central consideration. [23]

# Conclusion

Applying contactless payment technology to transit systems is a natural progression. With significant innovation in recent years and increased user adoption of contactless payments, using existing payment technology to deliver operational efficiencies and improve the customer experience across transit networks is now a significant option for transit authorities.

Today, we see a competitive landscape featuring more suppliers of fare collection systems, either using commodity EMV readers or with their own reader certified by EMVco. We also see many successfully deployed contactless transit payment projects live across the globe, and many more are already in progress.

With an open-loop system, interoperability comes out of the box and leveraging EMV standards means that transit technology is likely to become obsolete less quickly. Adopting these standards also allows transit authorities to benefit from third party investment from the financial services sector.

The business case for open-loop transit ticketing is strong, and many innovative cities and their transit authorities now look to achieve the reduced COFC, increased customer satisfaction and interoperability already experienced by cities across the globe that have moved to this attractive new system.



# Appendix

## Appendix 1: Contract wins in open-loop payments

| Transport operator | Contract value | Description |
|---|---|---|
| Budapest: BKK (2014) [24] | 91 million Scheidt and Bachmann | Design-build-operate-maintain (DBOM) contract (five years operate-and-maintain), including 10,000 validators, 800 access gates, and 1.5 million smart cards. |
| Singapore (2016) [25] | S$1,955,625.48 Orange Business Services Singapore | Provision of EMV-compliant transit back-office and payment gateway, including functionality for back-office management of open-loop EMV payment cards. |
| Dallas: Dallas Area Rapid Transit (DART) (2015) [26] | US$30 million Vix technology | Contract comprised implementation of the Vix "Easy and Open" eO product. Account-based architecture, delivering open payments within a PCI-compliant fare-collection platform. |
| Washington: WMATA (2015) [27] | US$184 million Accenture | DBOM contract (5 years operate and maintain). |
| Philadelphia: SEPTA (2011) | Contract value: 174 million | SEPTA will have an option to purchase $83 million worth of additional services for the second through fifth years after the system is installed, as well as another $91 million worth of services for years 6 through 10. |
| Portland, Oregon: TRIMET (2014 [29] | US$14.4 million INIT | Contract comprised account-based fare management system, supporting closed-loop cards and open payment, 1,100 validators, 90 inspection devices, 100 POS units, and 1.3 million smart cards.<br><br>TriMet commented that the system would likely cost c.US$30m to implement in total, including:<br>• Seven years of software-maintenance support<br>• Additional contract for TVMs<br>• Expanding and integrating the retail network<br>• Updating the smart phone app<br>• Civil work to prepare light-rail station platforms for installation of eFare validators |
| Chicago Transit Authority (CTA) (2011) [30] | US$454 million Cubic<br><br>(has since in-creased to c.US$519 million) | Capital cost to replace systems was c.US$140m, including<br>• Readers<br>• Vending machines<br>• Network devices<br><br>The contract included updates to 1,886 buses and 774 rail gates. |

## Appendix 2: Estimates of total variable bank-related costs under three scenarios:

**Table 1: No contactless payments**

| Channel | Assumed Channel Mix | Revenue Collected (AUD$) | Assumed Fees | Assumed Fee (AUD$) |
|---|---|---|---|---|
| TVM or Ticket Office (Cash) | 20% | 20.00 | 3% | 0.60 |
| TVM or Ticket Office (Card) | 20% | 20.00 | 2% | 0.40 |
| Retail | 40% | 40.00 | 5% | 2.00 |
| Web/ Autoload | 20% | 20.00 | 2% | 0.40 |
| Total Revenue collected | | 100.00 | | 3.40 |

**Table 2: 20% Contactless payment market share and MSF Model 1**

| Channel | Assumed Channel Mix | Revenue Collected (AUD$) | Assumed Fees | Assumed Fee (AUD$) |
|---|---|---|---|---|
| TVM or Ticket Office (Cash) | 10% | 10.00 | 3% | 0.30 |
| TVM or Ticket Office (Card) | 20% | 20.00 | 2% | 0.40 |
| Retail | 30% | 30.00 | 5% | 1.50 |
| Web/ Autoload | 20% | 20.00 | 2% | 0.40 |
| Contactless (with Daily Settlement) | 20% | 20.00 | 5 x $0.04 + 2% | 0.60 |
| Total Revenue collected | | 100.00 | | 3.20 |

**Table 3: 20% Contactless payment market share and MSF Model 2**

| Channel | Assumed Channel Mix | Revenue Collected (AUD$) | Assumed Fees | Assumed Fee (AUD$) |
|---|---|---|---|---|
| TVM or Ticket Office (Cash) | 10% | 10.00 | 3% | 0.30 |
| TVM or Ticket Office (Card) | 20% | 20.00 | 2% | 0.40 |
| Retail | 30% | 30.00 | 5% | 1.50 |
| Web/ Autoload | 20% | 20.00 | 2% | 0.40 |
| Contactless | 20% | 20.00 | 2% | 0.40 |
| Total Revenue collected | | 100.00 | | 3.00 |

## Links on-line for delivered and existing open-loop projects.

The Netherlands -
https://www.youtube.com/watch?v=VFMF0w4nGpA

UK Buses -
https://www.firstgroup.com/about-us/news/major-transport-operators-consider-transformational-plan-contactless-travel-every-bus

New York -
http://www.digitaltrends.com/cool-tech/mta-subway-contactless/

Budapest -
http://www.bkk.hu/en/2014/10/budapest-signed-the-contract-agreement-for-the-automated-fare-collection-system/

Toronto -
http://www.metronews.ca/news/toronto/2015/11/18/apple-pay-coming-to -the-ttc-.html

Singapore -
http://www.nfctimes.com/news/singapore-transit-authority-eyes-open-loop-fare-collection-which-would-compete-its-ez-link-sche

Sydney -
https://www.opal.com.au/en/news/opalnews/news_19April2016.html

Paris -
http://www.lejdd.fr/JDD-Paris/Pecresse-au-JDD-Le-ticket-de-metro-sera-supprime-786799

Philadelphia -
http://www.septa.org/media/releases/2016/06-10-16.html



# Glossary of terms

### Card-based ticketing

Traditional card-based transit fare payment systems store value and the information about cardholder entitlements required for calculating a fare securely within the smart card's memory. All transactions are managed and tracked on the card. Stored value schemes are considered to be closed-loop, as the value stored cannot typically be spent outside of the public transit network, and the transit authority must typically procure the cards and issue them to its customers.

Fare payment devices authenticate the card, calculate the fare and upload usage data to the central system where a master database of all cards registered in the system is maintained. All fare logic and related equipment operating data needs to be present on all front end devices. The system must also provide facilities for the cardholder to reload products or value onto their cards.

### Account-based ticketing

Account-based ticketing is a method where the proof of entitlement to travel (stored value or products) and any records of ticket usage are held as records within a central account-based ticket sales system, and not in any physical media held by the passenger. The smart card is replaced by a more generic token such as an ID card. The customer's token is registered against that account along with an agreement to pay for usage (e.g. by direct debit from a customer's bank account). These systems can involve either post-payment or pre-payment. All applicable fare logic, including capping, is applied at the back office. Credentials such as products and concessions are held within the customer's account in the back office, where they are used when calculating fares.

### Open-loop ticketing

The term open-loop ticketing applies to systems that accept payment media typically used outside of the transit network, such as contactless payment cards (credit, debit and prepaid), as tokens at the validator or gate. Acceptance of bank-issued tokens requires the system to comply with specific banking standards such as EMV and Payment Card Industry Data Security Standard (PCI DSS). Open payment card acceptance eliminates the initial steps of buying a transit fare card and loading value onto it.

### Aggregated fares

Tap-on/tap-off transactions are aggregated in the back office and applicable fare logic (e.g. capping) is applied before payment is collected through the merchant acquiring bank.

### Near-field communication (NFC)

NFC technology is a set of protocols enabling electronic devices to communicate when brought into close contact (within ca.4cm). When applied to smart phones, NFC enables contactless payment using virtualised bank payment cards.

### Brownfield v greenfield sites

In relation to the implementation of open-loop automatic fare collection technology, transit networks are defined as either brownfield or greenfield, depending on whether other, closed-loop, automatic fare collection technology is already installed.

Brownfield sites currently have a smart card or other automatic fare collection system implemented. Large brownfield transit operators that have implemented open-loop ticketing include TfL (which implemented open-loop contactless payment to complement and eventually replace the existing Oyster card system), and Chicago (which implemented the Ventra system to replace the Chicago Card).

Greenfield sites currently do not have a smart card or other automatic fare collection system implemented. Greenfield transport operators that have implemented open-loop ticketing include that of Salt Lake City, Utah, which implemented open-loop ticketing in tandem with the introduction of its AFC system.

### Issuing v acquiring banks

The acquiring bank is the institution where the merchant in question has their bank account. The issuing bank is the institution that issued the payment card that the customer used in the transaction. When a transaction is made, the acquiring bank typically pays the issuing bank an interchange fee. Usually, this fee is passed on to the merchant and deducted from the value of the transaction.

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## About L.E.K. Consulting

L.E.K. is a global management consulting firm with 21 offices across the Asia-Pacific, Europe and the Americas. We are recognised as one of the world's leading consulting firms, helping clients to deliver tangible results. We do this through a combination of deep business experience and expertise, applying analytics and strategic thinking to complex issues – we help organisations make and apply critical business decisions with certainty.

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## About Mastercard

Mastercard is a technology company in the global payments industry, operating the world's fastest payments processing network, connecting consumers, financial institutions, merchants, governments and businesses in more than 210 countries and territories. Mastercard's products and solutions make everyday commerce activities – such as shopping, travelling, running a business and managing finances – easier, more secure and more efficient for everyone. Mastercard is committed to helping cities become more inclusive, more sustainable and more open – by applying technology, data and partnerships to the challenges of an increasingly urban world.

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## Notes


L.E.K. and Mastercard have used 100% environmentally friendly resources in the production of this report.