A CASE STUDY ANALYSIS OF NEW FARE PAYMENT SYSTEMS IN PUBLIC TRANSIT

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Joel David Anders
450 North Highland Avenue NE, Unit A, Atlanta, GA 30307
Phone: (813)-546-7565 Fax: Not Available
Email: anderstransit@gmail.com

Candace Brakewood (Corresponding Author)
School of Civil and Environmental Engineering
Georgia Institute of Technology
790 Atlantic Drive, Atlanta, GA 30332
Phone: (803)-727-3317 Fax: Not Available
Email: candace.brakewood@gatech.edu

Dr. Kari Watkins
School of Civil and Environmental Engineering
Georgia Institute of Technology
790 Atlantic Drive, Atlanta, GA 30332
Phone: (206)-250-4415 Fax: (404) 894-2278
Email: kari.watkins@ce.gatech.edu

ABSTRACT

Some American transit agencies are deploying new fare payment systems, including open payments and mobile payments. Other transit authorities want to understand how and why these agencies are implementing new fare collection systems. Therefore, the objective of this study is to conduct an exploratory analysis of agencies deploying new fare payment systems. The method used to conduct this research is detailed case studies, which are compiled by reviewing documentation and conducting interviews with transit agency staff in three cities: Chicago, Philadelphia, and Portland. Each case study is evaluated on seven dimensions: current fare collection system, rationale for the new system, technology selection, benefits of the new technology, costs, contract structure, and other noteworthy elements. The results of this qualitative analysis reveal that the primary reasons for deploying new systems are increased customer convenience, replacement of aging equipment, and potential reductions in fare collection costs. The new technology selection is influenced by the existing fare collection system; specifically, the barrier-free system is deploying mobile payments, whereas the two gated systems are implementing open payments. In terms of contract structure, two of the agencies utilized innovative financing strategies in which the transit agency does not expend significant upfront costs but ties third party payment to service fees associated with transactions on the transit system. The case studies suggest that these two new types of fare collection will converge to an open-standards based model with acceptance of near field communications (NFC)-enabled devices, once these devices are more commonly used for payments.

INTRODUCTION

One of the most rapidly evolving technological areas in public transportation is new fare payment systems. Historically, transit agencies collected fares by accepting cash payments, paper tickets, or metal tokens. In the latter part of the twentieth century, many transit agencies implemented automated fare collection (AFC) systems, including most of the largest operators in the United States. AFC systems are characterized primarily by magnetic stripe tickets and proprietary, transit-only contactless smart cards *(1, 2).*

In the last few years, there has been a push toward two new fare payment technologies in the transit industry. These "next generation" fare collection systems include open (standards) payment systems and mobile ticketing. Open payment systems accept contactless prepaid, credit or debit cards or near field communication (NFC)-enabled devices directly at faregates in rail stations and at fareboxes on buses. In mobile ticketing systems, riders pay using smartphone applications (without using NFC in the transaction). Transit agencies in the United States are designing and deploying both of these new fare payment technologies at an extraordinary pace.

In terms of open payment systems, a leader in implementation is the Utah Transit Authority (UTA) in Salt Lake City, which accepts contactless bankcards system-wide and recently began a pilot program to accept NFC payments using Isis and Google Wallet *(3).* In September 2013, the Chicago Transit Authority (CTA) became the second transit agency in the United States to accept open payments system-wide when the Ventra system was launched *(4, 5).* Other agencies are planning to deploy open payment systems in the near future, including the Southeastern Pennsylvania Transportation Authority (SEPTA) in Philadelphia *(6)* and the Washington Metropolitan Area Transit Authority (WMATA) *(7).* Small-scale pilot programs deploying contactless card technology have been delivered in New York, New Jersey, and Pennsylvania. The Metropolitan Transportation Authority (MTA) in New York City partnered with the Port Authority of New York and New Jersey (PATH) and New Jersey Transit (NJ Transit) to conduct a pilot program for contactless bankcard acceptance on select train and bus routes in 2010 *(8).* Additionally, the Port Authority Transit Corporation (PATCO) in Pennsylvania and New Jersey has recently conducted a pilot program for contactless prepaid Visa cards *(9).*

Simultaneously, many other transit operators have begun to deploy mobile ticketing systems that rely on smartphone applications for payment. The Massachusetts Bay Transportation Authority (MBTA) in Boston began a system-wide commuter rail program for mobile ticketing in the fall of 2012 *(10).* In September 2013, the Tri-County Metropolitan Transportation District of Oregon (TriMet) in Portland launched a mobile ticketing program for buses and trains *(11),* and the Dallas Area Rapid Transit (DART) partnered with two other Texas agencies to deploy mobile ticketing for buses and trains in September 2013 *(12).* New Jersey Transit began a pilot program for mobile ticketing on commuter rail in April of 2013 and is in the process of expanding to additional rail lines *(13).* The Metropolitan Transit System (MTS) in San Diego is currently conducting a pilot program for mobile payments to football games and special events *(14),* and the Long Island Rail Road (LIRR) conducted a similar mobile ticketing pilot for travel to a golf tournament in 2012 *(15).* Metro North Railroad (MNR) in New York and Connecticut has tested mobile tickets with railroad staff *(16).* Last, Virginia Railway Express (VRE) in northern Virginia recently underwent a procurement process for mobile ticketing *(17).*

The sheer number of pilot programs, procurement processes, and pending deployments demonstrates the importance of new fare payment systems in the public transportation industry. Therefore, this study aims to capture early trends by conducting detailed case studies of three leading transit agencies that are actively implementing new fare payment systems.

OBJECTIVES

Given this rapid movement toward new fare payment systems, this research aims to understand why and how transit agencies are implementing new fare payment systems. Detailed case studies of three transit systems were conducted in order to identify the different approaches used by agencies. These case studies answer the following overarching questions:

(1) Why are these transit agencies deploying new fare payment systems?

(2) How are these new fare payment systems being implemented?

This qualitative analysis will help to inform planners and decision-makers at other transit agencies who would like to pursue new fare payment systems, particularly open payment systems and mobile ticketing using smartphone applications.

METHODOLOGY

A case study methodology was selected for this analysis. According to Yin, case studies are an applicable research method for situations in which the following three criteria are met:

1. The research seeks to answer a "why" and/or "how" question,
2. The research focuses on contemporary events, and
3. The researchers lack "control over behavioral events" relevant to the research *(18).*

Given the previously stated objective to answer "why" and "how" questions of present-day decisions made by transit agencies regarding new fare payment systems, a case study methodology was deemed appropriate. A multiple case study research design was deemed superior to a single, in-depth case study because numerous institutional, technological, economic and operational factors may affect the design and delivery of each new fare payment system.

Case Study Selection

The case studies selected for this analysis were the Chicago Transit Authority (CTA), the Southeastern Pennsylvania Transportation Authority (SEPTA) in Philadelphia, and the Tri-County Metropolitan Transportation District of Oregon (TriMet) in Portland. These case studies were selected based on four criteria: size of the transit agency, modes operated, current fare media, and state of the new fare payment system.

First, the size of the transit agency could be an important factor because large transit operators are likely to have the most resources available (and face the toughest challenges) when implementing new fare payment systems. Therefore, the twenty largest transit operators in the United States, based on unlinked passenger trips, were considered for this analysis *(19).*

Second, all three of the selected transit agencies operate extensive multi-modal transit networks. Implementing a comprehensive fare payment system in a multimodal network may be more complex than deploying a new payment system on a single mode, since certain fare collection approaches (i.e. barrier, pay on board, proof-of-payment and conductor validated) are often associated with particular modes of transit *(1).* Therefore, findings for complex multi-modal networks may be easier to generalize to other metropolitan areas. The CTA operates the elevated railway network ("L" trains) and the bus system in the greater Chicago area, SEPTA operates urban bus, heavy rail, light rail, and commuter rail in the Philadelphia region, and Portland operates light rail, urban bus, commuter rail, and is under contract with the City of Portland to operate the streetcar system.

The third criterion was the fare media used in the current fare collection system. The CTA has an automated fare collection (AFC) system that accepts smart cards and magnetic stripe tickets. SEPTA is primarily a token-based system, but the agency also uses magnetic stripe

tickets for some period passes and accepts paper tickets on commuter rail. Finally, TriMet has a paper-based ticketing system. Given the different levels of technology associated with each of these fare media, it was envisioned that the current form(s) of fare media could have a significant impact on the technology pursued in the new fare payment system. For example, transit agencies that currently operate a card-based fare collection system (e.g. smart cards) may be more likely to transition to a future system that is also card-based (e.g. open payments) for reasons of operational similarity or customer familiarity. Subsequently, three cases with different forms of fare media were chosen for this analysis over other systems that utilize similar fare media.

Last, while many large transit agencies in the United State are initiating the process of moving to new fare collection systems, the case studies selected for this research represent those transit agencies that were deemed most ready to move forward with system-wide implementation of next generation fare collection systems. Some other large transit agencies have already implemented instances of new fare payment systems; however, the majority of these instances were temporary (e.g. limited pilot demonstration projects). Due to the temporary nature of pilot projects and the fact that they were primarily undertaken to test the technological and operational feasibility of new payment methods, these cases were not included in the research.

The four criteria for case study selection are summarized in Table 1 for each of the three transit agencies selected for this analysis.

TABLE 1 Case Study Selection Criteria

Transit Agency	**Chicago Transit Authority (CTA)**	**Southeastern Pennsylvania Transportation Authority (SEPTA)**	**Tri-County Metropolitan Transportation District of Oregon (TriMet)**
Urbanized Area	Chicago, Illinois	Philadelphia, Pennsylvania	Portland, Oregon
Annual Unlinked Passenger Trips, Thousands* (Ranking)**	516,783 (2)	346,884 (6)	104,340 (13)
Modes Operated	Urban Bus, Heavy Rail	Urban Bus, Heavy Rail, Light Rail, Commuter Rail	Urban Bus, Light Rail, Commuter Rail, Streetcar***
Fare Media in Current System	Smart Cards, Magnetic Stripe Tickets, Cash	Tokens, Magnetic Stripe Tickets, Paper Tickets, Cash	Paper Tickets, Cash
Deploying a New Fare Payment	Yes	Yes	Yes
**Unlinked passenger trips rounded to the nearest thousand*			
***Number of trips & national ranking from the 2012 APTA Fact Book using 2010 statistics (19)*			
****TriMet operates the streetcar under contract with the City of Portland*			

Documentation

Various types of evidence can be used to conduct a case study analysis *(18)*, and this research drew primarily on two types: documents and interviews. Documents were gathered from transit agency websites, meeting minutes from agency board meetings or other public meetings, publications from local news media, and Request for Proposals (RFPs) related to new fare collection systems. The documentation allowed for a preliminary assessment of each existing and future fare collection system, which provided the basis for drafting interview questions. After collecting and analyzing the relevant documentation, a single structured interview was conducted with a key official within each case study agency's fare collection department, and follow-up questions were sent via email as needed. Supplemental interviews were also conducted with other experts, including contractors.

LITERATURE REVIEW

There is limited literature on transit fare collection systems. Multisystems, Inc. has conducted two in-depth studies of fare collection systems that provide an overview of the underlying technology and collection procedures that transit agencies have utilized *(1, 20)*. Their 2003 report introduces two dimensions to fare collection: the approach used to collect the payment (i.e. barrier, pay on board, proof-of-payment and conductor validated) and the media utilized to pay the fare (i.e. cash, tokens, paper tickets, magnetic stripe cards, smart cards and other emerging methods). Two key contributions of this report were the conclusion that fare collection approaches are closely associated with particular modes of transportation, as well as an overview of the relative strengths and weaknesses of magnetic stripe and smart card fare media *(1)*.

Recent developments within the payments industry combined with the increased market penetration of smartphones and bank-issued contactless cards have allowed alternative approaches of fare collection to emerge. These alternatives fall into two categories, open payments and mobile ticketing, which are discussed in the following paragraphs. The key feature that distinguishes these two emerging approaches from their AFC predecessors is that these are account-based systems in which data are stored in back-office systems, as opposed to on a smart card or magnetic stripe ticket. These emerging payment methods should allow the transit agency to transition from its current active role as a media issuer and fare collector to one in which the agency can take a more passive approach and become an acceptor of standardized payments, thus potentially reducing the resources required to collect fares *(21)*.

Open Fare Payments Systems

Open Fare Payment Systems "OFPS" *(22)* or Open Standards Fare Systems "OSFS" *(23)* refer to the use of non-proprietary communications protocols that have been developed by the payments industry to allow customers to pay for products using standardized technology platforms and devices. Open payments allow transit customers to pay their fares using a variety of payment methods and do not limit them to just utilizing a transit agency-issued smart card. Open payments can be made utilizing contactless credit and debit cards (collectively referred to as contactless bankcards) or contactless prepaid cards. Contactless prepaid cards are different from traditional stored value cards because they have value or data maintained in back-office computer systems, whereas stored value cards (such as transit-issued smart cards) store funds or data on the card itself. Furthermore, contactless prepaid cards are generally divided into two types based on how the card can be used. "Closed loop" prepaid cards are only accepted at a

single merchant or chain of merchants (i.e. the transit system). "Open loop" prepaid cards, which are also referred to as network-branded or general purpose reloadable prepaid cards, carry the label of a major payment network (e.g. Visa or MasterCard) and can be used at any major retailer that accepts that networks' credit or debit payments *(4).* Open payment systems may also accept transactions using NFC-enabled devices, such as smartphones, with this "tap" technology.

There is significant industry interest surrounding this approach to fare collection due to the benefits that may be realized by the agency related to reducing current cost to collect fares *(21).* Additionally, the transit industry has faced challenges integrating fare collection systems across regions, causing intercity travelers to carry and load multiple cards, and open payments can facilitate interoperability between regions by using standardized technology *(2).* Another potential benefit is enhanced interoperability with non-transit merchants (i.e. McDonald's, CVS/pharmacy) surrounding the transit system, which may increase customer convenience *(24).*

Mobile Payments with Smartphone Applications

This method of payment usually involves the transit agency seeking a software development firm to create a smartphone application that can be used by riders to purchase fares. Within this paper, "mobile payments" refer specifically to fares purchased via a mobile ticketing application that does not require the customer to "tap" at a farebox or gate *(10).* This is distinct from open payment fares purchased over mobile phones that require an NFC transmission for the user to "tap" into the system. In addition to widespread market penetration of smartphones, this payment medium offers another noteworthy benefit: mobile ticketing applications can also provide the transit customer with additional transit-related features, such as a readily accessible account management platform, real-time and position-based advertising, information about service alerts, and real-time vehicle location information.

CASE STUDIES

The following section describes the detailed results from the case studies. Each case study was compiled to compare seven dimensions. The first two dimensions explore the question of ***why*** transit agencies are implementing new fare payment systems: [1] the current fare collection system and [2] reasons/rationale for making changes to the existing system. The next four dimensions seek to answer the question of ***how*** these new fare payment systems are being implemented, including [3] the type of future fare payment technology and fare methods used, [4] the benefits of selecting this future fare collection system, [5] the anticipated costs of the new fare collection system, and [6] the contract structure. The final dimension [7] functions as a "catch-all" category to incorporate additional noteworthy features, policies, or other items. These seven dimensions are shown in Table 2, and they are discussed for each of the three case studies in the following sections, beginning with Chicago.

TABLE 2 Seven Dimensions of New Fare Payment Systems

Question	Dimension	Chicago	Philadelphia	Portland
Why?	**Current Fare Collection Methods**	• Barrier: Heavy Rail	• Barrier: Heavy Rail	• Proof-of-Payment: Bus, Light Rail, Streetcar & Commuter Rail
		• Pay On-Board: Bus	• Pay On-Board: Light Rail, Streetcar & Bus	
			• Conductor-validated: Commuter Rail	
	Rationale to Change Existing System	• Aging existing equipment	• Increasing obsolescence of aging existing system	• Increase customer convenience
		• Reduce fare collection costs	• Increase customer convenience	• Reduce fare collection costs
How?	**New Fare Payment System**	• Open Payment System: Ventra card (plastic) & ticket (paper)	• Open Payment System: Closed loop contactless prepaid card (initially)	• Mobile Ticketing Smartphone Application
	Benefits of New Fare Payment System	• Increased customer convenience	• Increased customer convenience	• Increased customer convenience
		• Potential reductions in fare collection costs	• Potential reductions in fare collection costs	• Potential reductions in fare collection costs
		• Increased flexibility to change fares and accept emerging payment	• Potential for faster transactions & passenger boarding	• Increased data about fare collection operations and enforcement
			• Potential reductions in fare evasion	
	Contract Structure	• Fixed base fee & variable (transaction-based) fee paid to vendor	• Fixed fee paid to vendor	• Variable (transaction-based) fee paid to vendor
	Cost & Duration	• $454M	• $129.5M	• Cost information not available
		• Contract length of 12 years	• Contract length of 4 years	• Contract length of 3 years
	Other Noteworthy Elements	• Partnered with Pace (suburban bus operator)	• Contract open to other Pennsylvania transit agencies	• Significant development and customer research period
		• Increased availability of fare products (within 1/3 mile of bus stops)	• Paratransit included in installation	• Long-term strategy is to pursue an open (electronic) payment system
		• Vendor responsible for paying transaction fees	• Installing gates (barriers) at 5 downtown commuter rail stations	
			• Significant public outreach and involvement	

Chicago, Illinois

Current Fare Collection Methods & Rationale to Change

The Chicago Transit Authority (CTA) operates a fare collection system utilizing barriers for heavy rail and a pay-on-board approach for buses. Transit riders can pay using magnetic stripe cards for pay-as-you-go fares and all period passes. Cash is directly accepted on bus fareboxes, but rail turnstiles are cashless. There are also two closed loop, proprietary contactless smart card options, the Chicago Card and the Chicago Card Plus, which are both stored value cards that offer pay-as-you-go fares. The Chicago Card Plus has added functionality for automatic refill of pay-as-you-go value or 30-day period passes by linking it with a credit or debit card *(25).*

The primary motivation behind upgrading the system is the age of the existing fare collection equipment (*26).* While smart cards have delivered many benefits to the CTA, the agency has run into a few challenges with the Chicago Card, including an increasing difficulty to procure replacement parts, such as the chips in the smart cards, and latency issues on-board buses. Additionally, the agency is looking to reduce the cost and labor burden of issuing fare cards and operating its fare collection system.

Description & Benefits of the New Fare Payment System

The CTA recently underwent a massive overhaul of its fare collection equipment in order to deploy its new fare payment system, known as Ventra. The implementation of Ventra has resulted in the acceptance of multiple forms of contactless payment, including Ventra cards/tickets and contactless bank-issued credit/debit cards. A Ventra card is a contactless MasterCard-branded plastic card that can be used for all fare types. It functions as a closed loop transit-only card unless the user chooses to register it and go through the Know Your Customer (KYC) process, which refers to the due diligence activities that financial institutions must perform to verify a cardholder's identify. After registration, the card can be used as an open loop prepaid debit card to make contactless payments at any regular merchant (i.e. McDonald's, CVS/pharmacy). For single rides and one-day passes, riders can also utilize the Ventra ticket, which is a contactless paper ticket. Both the paper Ventra ticket and plastic Ventra card allow riders to transfer between CTA routes within a time window of two hours. During the transition period from the current system to Ventra, the CTA continues to accept all existing payment methods, but the proprietary magnetic stripe and Chicago Cards will be gradually phased out *(5).* The CTA plans to accept payment via NFC-enabled devices in the future.

Benefits of the Ventra system include enhancing the customer experience and addressing a variety of agency goals *(23).* Ventra may be more convenient for customers who supply their own forms of transit fare payment (e.g. contactless bankcards) because they do not have to travel to a retail outlet or ticket vending machine (TVM), thereby potentially reducing travel time. Additionally, the acceptance of rider-provided fare media will reduce demand for agency-issued fare media over time, which may reduce the agency's operating cost related to printing and distributing its own media. By moving to an account-based system, the CTA expects that Ventra will provide the agency with additional flexibility to implement fare changes in the future because the fare rules and processing are done on a central server. Similarly, by using standards-based equipment, the CTA is well-positioned to accept emerging payment technologies, such as NFC. Finally, by migrating to a fare collection system that is continuously online, Ventra provides planners at CTA with timely data on ridership and revenue *(23).*

Contract Structure & Costs

The move to Ventra involved new equipment installations to replace existing vending machines at all CTA rail stations, replacing existing readers on all CTA buses, and expanding the retail network from 600+ locations to nearly 2,500 *(23).* The sheer size of the CTA network played a critical role in the agency's contractual approach to upgrading its fare collection system. In November 2011, the CTA reached a $454M agreement with its current vendor to replace all of the proprietary fare collection equipment in favor of an open standards fare collection system. The contract is expected to save the agency approximately $50M in capital and operating expenses related to fare collection over the twelve year term of the contract *(27).*

While it is common practice in the transit industry to pay the capital costs upfront and then pay operating and maintenance costs on a periodic basis, the extent of replacement and a limited agency budget necessitated an alternative approach for the agency. The CTA structured its contract based on a base fee, which is a fixed monthly payment beginning upon full implementation meant to cover procurement and migration costs, and a "per tap" fee, which is a variable monthly payment beginning at the start of transition and is intended to cover all other costs associated with implementation and operation over the life of the contract *(28).* The structure is such that the vendor was incentivized to provide a functional system as soon as possible, in order to begin receiving payment.

Other

There are a number of additional noteworthy elements of the CTA's new fare payment system. First, Chicago's suburban bus operator, Pace, was attached to CTA's contract via a $50M option. This is an important step toward regional interoperability, which was mandated by the State of Illinois for Pace, Metra (commuter rail), and the CTA by 2015 *(29).* In terms of customer improvements, there are stipulations within the contract that require the vendor to maintain a retail outlet within one-third mile of every bus stop, thereby increasing the relative availability of fare products. Finally, the agency has delegated the responsibility of paying third party transaction fees (Visa, MasterCard and other payment networks) to the vendor, which mitigates a financial uncertainty related to implementing open payments on transit.

Philadelphia, Pennsylvania

Current Fare Collection Methods & Rationale to Change

The Southeastern Pennsylvania Transportation Authority (SEPTA) fare collection system utilizes barriers for subway and pay on-board for light rail, bus, and streetcar. For these modes, there is a flat fare that can be paid via cash, magnetic stripe passes, and tokens *(30)*. For commuter rail, the authority operates a zonal fare system and utilizes a conductor-validated approach for verification of paper tickets. Fare products include single ride fares, as well as daily, weekly and monthly passes.

As stated on the SEPTA website, a primary motivation to migrate to a new fare collection system is that "the current fare system is a barrier to transit use," and riders have run into a variety of problems related to the reliability and functionality of the existing system *(6).* The existing system has aging electronic components in the fareboxes and an outdated operating system, which make it difficult to improve the current fare collection system. Additionally, the new fare collection system will provide customers with more convenient ways to pay for their fares *(26).*

Description & Benefits of the New Fare Payment System

Under the label of New Payment Technologies (NPT), SEPTA is in the midst of replacing all of its fare collection system in order to support open payment technologies. The implementation of the NPT project will allow customers to begin paying fares first via an agency-branded contactless closed loop prepaid card. To transfer between SEPTA routes, riders will use this prepaid card, since the new system will not accept metal tokens or paper transfers. Once the functionality of the new contactless system is established, the agency will then expand its accepted payment media to include bank-issued contactless credit/debit cards, and eventually NFC-enabled devices and frequency operated buttons (i.e. RFID badges issued by an employer or university). The agency will continue to offer its existing fare products across all of the new fare payment media.

In terms of the benefits of NPT, SEPTA conducted stakeholder meetings with its Fare Policy Advisory Group to determine the goals and priorities of the project prior to seeking financing. On the customer side, the NPT project is expected to increase ease of use and convenience of fare payments, minimize change during the transition from old to new technology, and provide for universal transfer capability between commuter rail and other modes of transit *(32)*. In anticipation of NPT, SEPTA has already begun installing the foundation of the new system's fiber optics and communications network as part of other on-going projects. Given that fare transactions currently utilize a dial-up server, the upcoming fiber optic payment system (subway) and wireless (regional rail and bus) may reduce transaction latency time by moving data faster. Additionally, there will now be back-end processing so that if a card has previously been presented to the SEPTA system, it will not require full authorization, thus potentially speeding up passenger throughput.

From SEPTA's perspective, adopting a modern fare payment system will directly address the agency's bottom line from multiple angles. From an economics perspective, accepting external contactless payments will likely "lower collection costs over time through reduced labor and material costs" related to collecting hard cash, as well as printing and issuing its own media. Additionally, phasing out tokens may reduce fare evasion. NPT will also provide the agency with additional flexibility to implement new fare policy changes that respond to changes in ridership patterns and broader changes within the transit industry. Last, NPT will allow the agency to harness the capabilities of fine-grained payment and ridership data in order to provide transportation services that more directly respond to customer needs *(26).*

Contract Structure & Costs

In terms of project costs, SEPTA was able to secure funding for NPT via a $175M loan from the Philadelphia Industrial Development Corporation in January of 2011. By February 2012, SEPTA had awarded a contract for implementation of the new fare collection system to its vendor worth $129.5 M *(32)*. The remaining portion of the loan ($45.5 M) will be applied towards funding operations and maintenance for the existing system, establishing an emergency fund to run the new system upon warranty's expiration, and upgrading all of its existing electronics, infrastructure and computer systems *(26).*

SEPTA has a 48 month contract with a vendor to design, install, and operate the system through the end of a one year warranty period. The warranty period starts at system acceptance. SEPTA has the option to continue system operation and maintenance with the vendor for three three-year option periods, for up to nine years. Payments are disbursed according to a "Milestone Payment Schedule" that identifies specific performance goals to be achieved. This contract

includes the complete replacement of the existing system, which will involve the installation of electronic readers on 1800+ fare boxes across all modes, 500 new subway turnstiles and 200 additional TVMs at subway and regional rail stations *(33).*

Other

SEPTA's NPT project is noteworthy for four additional reasons. First, while SEPTA is the sole party to the contract, the agency has issued an open invitation to all Pennsylvania public transit operators for SEPTA to act as their procurement agent for new fare collection equipment. Second, SEPTA, which operates the majority of paratransit service in the metro area, will install the new fare collection equipment on all of its ADA-equipped vehicles in order to provide for future interoperability with other providers. Third, as a way to reduce overall capital investment and simultaneously limit fare evasion at regional rail lines, SEPTA will be installing electronic targets (readers) at regional rail stations and outfitting five center city stations with turnstiles, instead of gating every single regional rail station *(26).* Last, since early 2011, SEPTA has continuously met with members of the general public, as well as municipal stakeholders, to develop the vision, goals and priorities for the new payment system and to perform user testing. To understand customer priorities, SEPTA held a series of rider focus groups and conducted multiple rider surveys, and some of these results are publicly available *(6).* The agency will continue its public outreach and educational efforts until the system is fully operational in late 2014.

Portland, Oregon

Current Fare Collection Methods & Rationale to Change

The Tri-County Metropolitan Transportation District of Oregon (TriMet) utilizes a proof-of-payment approach for fare collection across all modes, and the system is free of gates or barriers. TriMet riders show their fare products to the driver upon boarding a bus or to the fare inspector upon request on other modes. Paper tickets are accepted on all modes, and cash is directly accepted on bus services or at TVMs on light rail platforms. TriMet operates a flat fare system. Transfers are allowed within a two hour window on validated (time-stamped) flat fare tickets. Pass products are provided for periods of one day, seven days, fourteen days, one month, and one year. Fare products can be purchased at neighborhood retail outlets, as well as TVMs inside stations and online *(34).*

The primary motivation behind changing the fare collection systems is to improve customer convenience. The agency would like to provide its riders with the ability to purchase fares anytime, anywhere. Additionally, the agency sought a means to carve out long-term cost efficiencies in its fare collection operation and service. Like most transit agencies, TriMet is currently involved in the expensive process of printing tickets, distributing them to local retail outlets, stocking TVMs, and counting cash fares.

Description & Benefits of the New Fare Payment System

In September 2013, TriMet launched a cross-platform mobile ticketing application that enables Portland area transit riders to pay for fares on any mode using their smartphone. Once a rider has purchased a ticket on their Android or iPhone, they must activate the ticket before boarding by clicking "use" the ticket within the application. Upon boarding a bus, riders show mobile tickets to the driver for visual inspection. On other modes, fare inspectors randomly select passengers

and visually inspect mobile tickets. Since all Tri-Met fare products are time-based, as opposed to trip-based, mobile tickets can be used to transfer between routes/modes by presenting the time-stamped ticket on their smartphone to the bus driver or fare inspector. For those without a smartphone, the fare collection environment did not change, and TriMet does not intend to reduce any existing channels for purchasing paper-based tickets after the mobile rollout. Thus, mobile ticketing is simply one more option that riders can utilize to purchase fares.

Aside from the mobile ticketing application developed for end users, the transit agency has two additional software tools. A Fare Inspector application allows fare enforcement personnel equipped with an iPhone and attached laser to scan QR codes displayed on mobile devices. A back-office application, which is called the Transaction and Operations Management System, allows transit agency staff to view analytics related to fare purchases, audit revenues, and review inspector activities. Additionally, the program gives management the ability to view the activity of fare enforcement personnel so that officers can be more effectively deployed.

One of the primary benefits of the mobile ticketing system is increasing convenience for customers. This may be more convenient for customers because smartphone users can now purchase fares with their credit/debit card anytime and anywhere, instead of having to travel to a TVM, neighborhood retail outlet, or get cash. Aside from increasing customer convenience, TriMet expects that implementing mobile ticketing will, over the long-term, allow the agency to diminish its role as an issuer of fare media and reduce the amount of fares purchased through more expensive sales channels like TVMs and collecting cash at the farebox. By reducing demand for fares purchased through these channels, the agency may realize savings through a reduction in TVM maintenance and cash collection costs. Last, the deployment of mobile ticketing on TriMet services grants the agency access to data on both fare collection and enforcement operations.

Contract Structure & Costs

In terms of project costs, the implementation of mobile ticketing did not require the installation of additional fare collection equipment. Instead, fare enforcement personnel in this proof-of-payment system utilize a tool consisting of an iPhone and an attachable device that will scan QR codes and verify tickets on mobile devices. Thus, instead of spending significant capital costs so that riders can use their own forms of payment, TriMet has developed a low cost flash pass that allows riders with smartphones to provide their own forms of payment.

In terms of contract structure, the vendor will be reimbursed for its efforts via a service fee that will be applied to all mobile ticketing transactions. It is expected that the contractor will receive a flat percentage of all fares purchased via mobile devices during the contract period, which is three years.

Other

Two other elements of TriMet's new fare payment system are noteworthy. First, TriMet and its contractor had an extensive market research period that allowed the team to identify functional priorities from the perspective of the future users. Prior to full rollout in September 2013, a beta test was conducted in the summer of 2013 with approximately 250 riders. Public interest in this beta test was very positive, which was demonstrated by the 1500+ requests from riders eager to try the new application. Second, TriMet recently announced that the mobile ticketing application is part of a larger "eFare" system strategy. By 2017, the agency hopes to implement an open

payment system that accepts transit-only contactless cards, contactless bankcards and NFC-enabled devices *(35)*.

COMPARISON & CONCLUSIONS

Comparison of the seven dimensions allows for some preliminary conclusions to be drawn from the three case studies. First, the existing fare collection system appears to have a significant impact on the choice of future fare technology. While it was originally envisioned that the current fare media (i.e. token vs. paper ticket vs. smart card) would be a key determinant of the future fare media, the current fare collection method may actually have a stronger influence. The proof-of-payment system has pursued mobile payments using smartphone applications, whereas the two systems with barriers are moving toward open payment systems. It should be noted that barrier-free commuter rail operations may be a problematic area in largely barrier-based fare collection systems, particularly when implementing open payments. SEPTA is planning to install gates at some of its commuter rail stations, whereas the commuter rail operator in Chicago (Metra) does not accept open payments.

The rationale to upgrade existing fare collection systems includes two key factors: replacing aging or outdated fare collection equipment and increasing customer convenience. An important benefit noted by all three transit agencies was the potential for reduced fare collection costs. An additional benefit of open payment systems is increased interoperability between transit providers, as well as other merchants, which results from migrating to standardized technology.

Comparison of contract structure and corresponding costs reveals that both Portland and Chicago advantageously utilized a new mechanism for financing fare collection. These two agencies chose to use service fees that are tied to the actual transactions in the new fare payment system, whereas the third city, Philadelphia, utilized a traditional, fixed fee approach. These agencies are able to engage in this innovative financing because the new systems possess sophisticated back-office processing capabilities that permit tracking of fine-grained revenue collection data.

Last, the technologies used in the three new fare payment systems were categorized by two separate models: open payments that rely heavily on card-based transactions and mobile payments that utilize smartphone applications. While these are currently two separate models of next generation fare collection systems, they are poised for convergence. The two agencies pursuing open payment systems both plan to accept NFC-enabled devices in the near future. Similarly, TriMet recently announced plans to integrate their mobile ticketing application into an open electronic fare collection system *(35)*. As NFC-enabled devices become more prevalent, it is envisioned that these two separate models will converge into a payment system in which mobile phones become the dominant form of fare media.

FUTURE RESEARCH

This study identified numerous trends in new fare payment systems that lead to avenues for future research. First, all three transit agencies cited potential reductions in fare collection costs as a primary benefit of their new fare payment systems. Further research should be conducted once these systems are implemented to analyze the costs of fare collection and determine if reductions were actually achieved. Similarly, this study was conducted while the three transit agencies were in the planning and early implementation stages of new fare payment systems. Future research could be conducted after these systems are fully implemented on a system-wide

scale to understand best practices in new fare payment system design and deployment by transit agencies. Furthermore, another avenue for future research is rider utilization of new fare media after implementation, including potential changes in travel behavior attributable to new fare payment systems and adoption levels by market segment. Specific market segments that warrant future research include those without access to smartphones and/or bankcards to assure equitable outcomes of new fare payment systems *(4).*

Last, this research conducted in-depth studies of a small sample of transit agencies, but there are many other American transit agencies planning new fare payment systems. Therefore, additional research could be conducted with a larger sample of transit agencies, and this could include a comparison of agencies that are transitioning to new fare payment systems to those who are foregoing investments. A recently awarded Transit Cooperative Research Program (TCRP) study may begin to fulfill this need by assessing the state-of-practice for open payment systems *(22).*

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