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Analysis of Cost Savings Due to Use of Smart Credit Cards For New York's MTA

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Introduction

The bank-issued smart credit / debit card at the transit gate[1] is the culmination of the trends in the transit industry toward outsourced fare collection, regional multi-use cards, private sector financing and pervasive electronic networks. The scheme integrates smart chip transactions into the existing infrastructure of credit card accounts, monthly statements and consumer convenience.

This paper analyzes the savings which could be realized by installing a smart credit card system in parallel with the existing MetroCard system.

The Rationale for Change

The MTA is able to realize enormous savings at virtually no cost by adopting a parallel smart credit card system. This section will demonstrate and quantify the savings. But first let's define some necessary terms.

Smart Card – A card that is embedded with either a microprocessor and a memory chip or only a memory chip with non-programmable logic. The microprocessor card can add, delete, and otherwise manipulate information on the card, while a memory-chip card (for example, pre-paid phone cards) can only undertake a pre-defined operation.

Integrated Circuit (IC) Microprocessor Cards offer greater memory storage and security of data than magnetic stripe cards. Chip cards also can process data on the card. These cards are used for a variety of applications, especially those that have cryptography built in, which requires manipulation of large numbers. Thus, chip cards have been the main platform for cards that hold a secure digital identity.

A radio-frequency communication between a chip and a reader device is the means of data exchange, identity verification, etc. There are two types: contact and contactless.

Smart Credit Card – A credit card with an RF chip implanted in it. In our discussion, we envision a contactless smart credit card.

Magnetic Stripe Card – A farecard like the MetroCard with a magnetic stripe used to transfer and store fare data.

Stored Value Card – A card like the MetroCard in which the card's value is contained on the card and not in a central computer account.

Account Based Card – A card like EZ-Pass in which the card's value is in a central computer account.

Penetration Rate – The percentage of new cards in use compared to the total ridership of the system.

Advantages of Smart Credit / Debit Cards

Historically, fare collection systems have proceeded through technological stages of development from tokens to magnetic stripe cards to account-based systems. The credit card account is a special case of the account-based system. Each stage of development brought its attendant advantages, as may be illustrated in the following list:

[1] In this document, occasionally the word "gate" is used in the general sense, which includes bus fare boxes.

- Magnetic-stripe instead of tokens
    - Accurate and efficient fare collection, better reporting

- Smart card instead of magnetic stripe
    - Less device maintenance, faster throughput at gates

- Account-based instead of stored value
    - Payment becomes unconscious -> increased transit usage
    - No vending machines -> less cash collection

- Credit card instead of house account-based
    - No card issuance or management; less back end management (integrator passes data to agency computer)
    - Minimized customer service
    - Risk management for bad cards; better security
    - Financed point-of-sale devices

The recommended system takes advantage of the possibility of financing point-of-sale devices with the savings generated by the smart credit card system.

In general, smart cards offer the following advantages over magnetic stripe technology:

Security – Smart card technology presents a fare medium that is more difficult to counterfeit than magnetic stripe technology. Reducing this and other types of fare abuse, such as rider fare evasion and counterfeiting of media, is extremely important, yet difficult to quantify. It is however, often an important impetus for active consideration of new technology.

Reliability – A key goal is the reliability of the equipment and the fare media. This includes both minimal system malfunctions and a high degree of accuracy in accounting for fares paid. Smart card technology tends to be more accurate and reliable than mag stripe technology. It is renowned for its accuracy and low error rates, which equates to higher transit revenues. To further elaborate, smart card equipment will be able to operate in the presence of airborne particles, grease, oil, moisture, wind, noise, vibration, demanding electrical environment and moderate temperature changes.

Convenience – Ease of use of the fare system by riders is an important expected benefit of new technology. Contactless cards offer greater convenience to the rider in that they do not have to be swiped like mag stripe cards. The cards/tickets can even remain in the users' purses, pockets or wallets. This is especially important for the elderly or those riders with disabilities. Additionally, contactless cards allow for increased throughput by speeding the boarding process.

Flexibility – Smart cards allow for a range of fare options that can be offered and an ability to modify the fare structure easily and as needed. With a mag stripe solution for single-use fare medium, a constraint may eventually be posed on the multi-use fare medium because of pricing limitations and inflexibility from the single-use fare medium. For example, an eventual move toward distance based pricing, peak/off-peak pricing, or any future developments of pricing strategy may be restricted by the inability to adjust the pricing scheme of the single-use passengers.

Compatibility – The single-use technology should be compatible – and allow for future fare integration – with the fare systems of other transit providers in the region. Making a full-commitment to an open architecture smart card system will not disallow future regional developments, like a proprietary mag stripe system might.

In the next section, we attempt to quantify the savings to be realized by the MTA from adopting smart credit cards.

Quantitative Assessment

The details of the fare collection system of the MTA were used to make a quantitative comparison between magnetic stripe MetroCards and contactless smart credit cards for passengers. The goal of the quantitative analysis was to determine the cost savings achieved by implementing a smart credit card solution running alongside of the MetroCards. The details of the model can be found in Appendix 2 at the conclusion of this report. The approach in creating the model is to compare the savings from the complete replacement of MetroCards by smart credit cards and then to multiply the savings by the penetration percentage of the new cards.

Step 1 – Mag Stripe Reader Elimination

The mag stripe card readers are estimated to cost $2,956 apiece. This is estimated by comparing the cost of a turnstile with a mag stripe reader ($18,400) with the cost of a turnstile without a mag stripe reader ($15,444). This estimate is then multiplied by the total number of turnstiles, 4,075, and amortized over the life of the equipment, which is estimated at 15 years. Therefore, the total annual subway reader cost savings from shifting to smart cards is $803,047. This same process was done for the 4,832 bus validating fare boxes with an annual savings achieved of approximately $952,226. It is important to notice that no additional smart card readers are needed, because the future fare collection system already requires RF readers for smart card validation. These readers will be able to recognize low-cost smart cards as well as smart credit cards, which will, as a result, require no additional capital expenditures. Thus the total annual savings due to the elimination of mag stripe readers is approximately $1,755,273.

Step 2 – Mag Stripe Reader Maintenance Elimination

Since a dual system will no longer exist, certain maintenance cost savings can be expected. This was calculated by reducing the maintenance FTE's by an assumed percentage based on estimated time spent on mag stripe reader maintenance. It was assumed that maintenance time is split evenly between turnstiles and TVMs. In turn, the turnstile maintenance time is again split evenly between actual turnstile maintenance and mag stripe reader maintenance. The resulting estimate is that 25% of all maintenance time would be spent on mag stripe reader maintenance. The estimate means that the work force of 600 field crew can be reduced by 25% of 150 FTEs. We estimate that a fully loaded MTA maintenance employee costs around $84,000 per year. This results in a reduction in costs of $12,600,000 per year by using smart cards instead of mag stripe. We also estimate that the associated parts and supplies maintenance costs are approximately 20% of labor costs, or $2,520,000. Again, both of these savings, which total $15,120,000 per year, are a benefit of not maintaining dual systems.

Step 3 – Mag Stripe Card Elimination

An additional savings will be the actual cost of the mag stripe cards themselves. It is estimated that at the volume demanded by the MTA, these are procured at a cost of $0.025 per card. With a current annual issuance of 272,685,000 per year, this amounts to an annual savings of $6,817,135.

Step 4 – Fare Evasion Savings

It is estimated that there is a loss of approximately 1.5% of revenue due to various forms of fare evasion. The model assumes that only 25% of that loss can be traced to magnetic stripe cards. This annualized revenue savings is estimated to be $24,541,688.

Step 5 – RF Reader Costs

It is hypothesized that RF readers can be leased from the integrator at a rate of approximately 0.3% of revenue from RF card use. By multiplying this by the total fare revenue, the lease cost is estimated to be $19,633,350 per year.

Step 6 – RF Reader Maintenance

RF readers are less expensive to maintain than mag stripe readers because they have no moving parts or friction. Nevertheless, they may break and have to be replaced. The calculation is similar to Step 3 above except we assume that only 5% of the service personnel's time will be spent on the RF reader mainte-

nance instead of 50% in the mag stripe case. Total RF reader maintenance costs are thus calculated to be $1,058,400 per year.

Step 7 – RF Card Costs

In the smart credit card business model, the cards are paid for by the card issuers; the transit agency pays nothing.

Step 8 – Fare Evasion Costs

Since RF technology presupposes to have fewer incidents of fare evasion, there will likely be some incremental revenue associated with the new technology. The model assumes that revenue loss from RF cards will be only 0.1% of all fare evasion, since smart cards are a fare medium that is extremely difficult to counterfeit. This annualized revenue cost is estimated to be $98,167.

Step 9 – Cost Comparison

Next, we sum all of the mag stripe costs and compare those to the RF costs, arriving at the conclusion that if the mag stripe system were completely replaced with RF cards, total savings would be $27,444,179 per annum.

Findings

Finally, we assume that only 5% of ridership will use the new RF cards the first year, 10% the second year, 20% the third, 30% the fourth, 40% the fifth, and 50% the sixth and succeeding years. Therefore we multiply one year's savings, indexed for 2.5% inflation, times the penetration rate of that year to get that year's savings. Summing over 15 years, we find that the MTA could save a total of $204,871,247 by adding a parallel smart card system.

Exclusions

The model above ignores the cost of the mag stripe card encoding machine and the labor to run it, commissions paid to MetroCard retail vendors, outsourced distribution of MetroCards, nor management of the extended sales network. It also ignores the savings realized by reduced customer use of vending machines, resulting in less cash collection and machine maintenance. It further does not include possible savings on credit card interchange rates which may be negotiated with the financial industry in a smart credit card scenario.

Conclusion

New York City is America's largest transit system. All of the savings from smart-card payments—less maintenance, less fraud, better integration and planning—are magnified by the scale of the system to very significant numbers.

Assumptions	Amt	Description, Notes
Capital Equipment – Amortization Period in Years	15	Useful Life of Capital Equipment
Time Allocation – TVM Maintenance	50%	Amt of Maint Time Spent on TVM
Time Allocation – Turnstile	50%	Amt of Maint Time Spent on Turnstiles
Turnstile Time Allocation – Turnstile	50%	Amt of Maint Time Spent on Turnstile
Turnstile Time Allocation – Mag Reader	50%	Amt of Maint Time Spent on Mag Reader
Parts/Supplies Percentage of Labor Estimate	20%	Est of Mag Stripe Associated Supplies
Estimated Revenue Loss Due to Fare Evasion	1.5%	Est. Rev Loss % Due to All Fare Evasion
Fare Evasion Attributed to Magnetic Stripe	25%	Rev Loss % Due to Mag Fare Evasion
CPI Rate	2.5%	Consumer Price Index growth rate
Turnstile Time Allocation – RF Reader	5%	Amt of Maint Time Spent on RF Readers. These are solid state modules, the replacement of which is fast.
Fare Evasion Attributed to RF	0.100%	Rev Loss % Due to RF Fare Evasion. Seoul's fault rate is extremely low, 0.0035%.

System Data	Amt	Description
Turnstiles – Traditional Tripod	4,075	Num of Traditional Turnstiles in the System
Validating Fare Boxes	4,832	Num of Bus Fare Boxes in the System
Turnstile Cost with Mag Reader	$18,400	Turnstile Cost with Mag Reader Included. The following data is taken from Boston. Please insert accurate data for your system.
Turnstile Cost without Mag Reader	$15,444	Turnstile Cost with Mag Reader Not Included
Labor	735	Number of People Employed for Maintenance
Shop Maintenance FTEs	135	Number of Maint FTEs not in the Field
Field Maintenance FTEs	600	Number of Maint FTEs in the Field
FTE Salary	$60,000	Maintenance FTE Salary
FTE Benefits	$24,000	Maintenance FTE Benefits at Load of 40%
FTE Total Compensation	$84,000	Maintenance Total Salary and Benefits
Per Card Cost	$0.025	Cost of a Paper Mag Card
Annual Cards Sold	272,685,417	Annual Cards Issued. Estimated.
Annual Regional Fare Revenue	$2,500,000,000	Transit Fare Revenue 2002 – 10K

Estimated Data	Amt	Description
Equipment Lease Fee	0.30%	Calculated as percentage of fare revenue

Model of Magnetic Stripe Card Costs

cost savings item	calculations	annual savings	data source
magnetic stripe readers			
subway			
Turnstiles – Traditional Tripod	4,075		system
Cost with Mag Reader	$18,400		system
Cost without Mag Reader	$15,444		system
Implied Mag Reader Cost	$2,956		calculation
Subway Total	$12,045,700		calculation
Amortization Period in Years	15		assumption
Mag Reader Subway Total – Annually	$803,047		calculation
Bus			
Validating Fare Boxes	4,832		system
Implied Mag Reader Cost	$2,956		calculation
Bus Total	$14,283,392		calculation
Amortization Period in Years	15		assumption
Mag Reader Bus Total – Annually	$952,226		calculation
magnetic stripe readers total		**$1,755,273**	**calculation**
mag stripe reader maintenance			
Labor			
Current Maintenance FTEs	735		system
Shop Maintenance FTEs	135		system
Field Maintenance FTEs	600		system
Time Allocation – TVM Maintenance	50%		assumption
Time Allocation – Turnstile, of which	50%		assumption
Turnstile Time Allocation – Turnstile	50%		assumption
Turnstile Time Allocation – Mag Reader	50%		assumption
Mag Reader FTE Equivalent	150		calculation
FTE Salary	$60,000		system
FTE Benefits	$24,000		system
FTE Total Compensation	$84,000		system
Mag Reader Maintenance Labor Total	$12,600,000		calculation
Parts / supplies			
Percentage of Labor Estimate	20%		assumption
Mag Reader Parts/Supplies Total	$2,520,000		calculation
mag stripe reader maintenance total		**$15,120,000**	**calculation**
magnetic stripe cards			
Per Card Cost (Black and White)	$0.025		system
Annual Cards Issued	272,685,417		calculation
magnetic stripe cards total		**$6,817,135**	**calculation**
fare evasion			
Annual System Fare Revenue	$2,500,000,000		system
Estimated Revenue Loss Due to Fare Evasion	1.5%		assumption
Fare Evasion Attributed to Magnetic Stripe	25%		assumption
fare evasion total		**$9,375,000**	**calculation**
total annual costs @ 100% penetration		**$33,067,408**	**calculation**
total revenue		**$2,500,000,000**	
costs as percent of revenue		**1.32%**	

Model of RF Card Costs

cost item	calculations	annual cost	data source	notes
RF readers				
Subway and Bus Equipment				
POS Device Lease	0.30%		estimate	
Annual System Fare Revenue	$2,500,000,000		system	
Lease annually	$7,500,000		calculation	
RF readers total		**$7,500,000**	**calculation**	
RF reader maintenance				
Labor				
Current Maintenance FTEs	735		system	
Shop Maintenance FTEs	135		system	
Field Maintenance FTEs	600		system	
Time Allocation – TVM Maintenance	50%		assumption	
Time Allocation – Turnstile, of which	50%		assumption	
Turnstile Time Allocation – Turnstile	50%		assumption	
Turnstile Time Allocation – RF Reader	5%		assumption	
RF Reader FTE Equivalent	15		calculation	
FTE Salary	$60,000		system	
FTE Benefits	$24,000		system	
FTE Total Compensation	$84,000		system	
RF Reader Maintenance Labor Total	$1,260,000		calculation	
Parts / supplies				
Percentage of Labor Estimate	20%		assumption	
RF Reader Parts/Supplies Total	$252,000		calculation	
RF reader maintenance total		**$1,058,400**	**calculation**	
RF cards				
Per Card Cost	$0.000		system	
RF cards total		**$0**	**calculation**	
fare evasion				
Annual System Fare Revenue	$2,500,000,000		system	
Estimated Revenue Loss Due to Fare Evasion	1.5%		assumption	
Fare Evasion Attributed to RF card	0.100%		assumption	
fare evasion total		**$37,500**	**calculation**	
total annual costs @ 100% penetration		**$8,595,900**	**calculation**	
total revenue		**$2,500,000,000**		
costs as percent of revenue		**0.34%**		

Comparison of ms and rf costs

cost item	ms annual cost	rf annual cost	rf system annual savings
readers total	$ 1,755,273	$ 7,500,000	$ (5,744,727)
reader maintenance total	15,120,000	1,058,400	14,061,600
cards total	6,817,135	-	6,817,135
fare evasion total	9,375,000	37,500	9,337,500
total	$ 33,067,408	$ 8,595,900	$ 24,471,508

Time Series

year	penetration	ms costs 100% costs	ms costs costs	rf costs 100% costs	rf costs costs	net savings 100% savings	net savings savings
1	5%	$33,067,408	$1,653,370	$8,595,900	$429,795	$24,471,508	$1,223,575
2	10%	33,894,093	3,389,409	8,810,798	881,080	25,083,296	2,508,330
3	20%	34,741,446	6,948,289	9,031,067	1,806,213	25,710,378	5,142,076
4	30%	35,609,982	10,682,995	9,256,844	2,777,053	26,353,138	7,905,941
5	40%	36,500,231	14,600,093	9,488,265	3,795,306	27,011,966	10,804,786
6	50%	37,412,737	18,706,369	9,725,472	4,862,736	27,687,265	13,843,633
7	50%	38,348,056	19,174,028	9,968,609	4,984,304	28,379,447	14,189,724
8	50%	39,306,757	19,653,379	10,217,824	5,108,912	29,088,933	14,544,467
9	50%	40,289,426	20,144,713	10,473,269	5,236,635	29,816,157	14,908,078
10	50%	41,296,662	20,648,331	10,735,101	5,367,551	30,561,560	15,280,780
11	50%	42,329,078	21,164,539	11,003,479	5,501,739	31,325,599	15,662,800
12	50%	43,387,305	21,693,653	11,278,566	5,639,283	32,108,739	16,054,370
13	50%	44,471,988	22,235,994	11,560,530	5,780,265	32,911,458	16,455,729
14	50%	45,583,787	22,791,894	11,849,543	5,924,772	33,734,244	16,867,122
15	50%	46,723,382	23,361,691	12,145,782	6,072,891	34,577,600	17,288,800
Over 15 years			$246,848,745		$64,168,535		$182,680,211