Need of the Study

Different Modes Different Fare Structures → **Hassle free and seamless travel**

Modern Technologies provide modern solutions

One Card Many Benefits

- Metro → Retail Shop
- Cab → Restaurants
- Buses → Retail Outlets
- Parking → ATM / Kiosk

Commuters

- Facilitates multi-modal travel behavior.
- Commuters just have to carry one card
- Encourages faster boarding
- Hassle free transaction. Enables commuters to enjoy the benefits of integrated fare policies.

Transport Authorities

दिल्ली मेट्रो रेल कॉर्पोरेशन लिमिटेड
Delhi Metro Rail Corporation Limited

- Collection of real time data
- Complex fare schemes.
- Help operators to balance peak and off peak patronage.
- Faster reconciliation of revenue with recorded data.
- It saves manhandling hours
- Increases the accountability and transparency of the transactions.
- Enables the authorities to maintain the extra sum of money

- Expandable to the other services like toll payment, congestion pricing in CBD areas, and parking and further for retail shopping.
- Elimination of fake currency from the economy.
- Increase the accessibility.

City	Deposit	Maximum Fare	% of deposit to maximum fare
London(pounds)	5	12.5	40%
Hong Kong (HK Dollar)	50	57	88%
Delhi	50	60	83%

Average 64%

| | | MRT, LRT, taxis, buses and road pricing | Transit, Retails, parking and tourism | Concession for children and students and senior citizens and Singapore Armed Forces, Singapore |

➤ Also, the deposit money charged is high when compare to the other global cities.
➤ Delhi being the most populous city of all the above mentioned ones still lags behind. The card is not multifunctional. It is limited to Transit. Even in transit it is limited to only bus and Metro.
➤ There is no incentive scheme.

| Card (One Delhi One Ride) | (2019) | 019) | | | | for card users and Concessional fares for Weekdays and Weekends |

Aim, Objective and Methodology

AIM : To study the user behavior to ease the mobility using common mobility card

Objectives:
1. To appreciate the types of smart card
2. To review the global best practices of using smart card for mobility.
3. To study the existing travel behavior of users.
4. To evaluate the travel behavior of non - users by expanding the smart card services
5. To estimate the economic benefits to users.
6. To list out the financial benefits to stakeholders

Listing of public transport scenario in Delhi and finalizing the scope for further study

Collection of Data

Primary data

- Socio-economic Data (Gender, Age, Vehicle ownership, Income, Educational Background, profession)
- Trip Characteristics (Trip Purpose, origin, destination, Trip length, Trip cost and Trip Time, Frequency of travel)
- Payment mode used and reason
- Rating of intermodal parameters
- Rating and Ranking of existing Card services

Secondary Data

- Ridership Data by DMRC and DIMTS, DTC
- Income generated by card (DMRC,DTC)

- Revealed Preference survey (PCA Analysis)
- Multi –Criteria Decision making analysis for intermodal parameters
- Stated Preference survey, Design of Experiments By orthogonal analysis
- Cojoint Analysis

Analysis of Data

Building up of Quantitative relationship between specific parameters and indicators using various statistical tools

Evaluating the economic benefits of the scenarios so generated

Policy Recommendations & Proposals

12th Urban Mobility India Conference & Expo 2019

Introduction: Study Area: Delhi

Delhi Metro

- Presently, the Delhi Metro network consists of about 373 Km with 271 stations.
- Currently, there are 8 lines and the airport express line
- Average Ridership of DMRC is 25.35 lakhs. *(Data as per RTI filed on 27/2/19)*
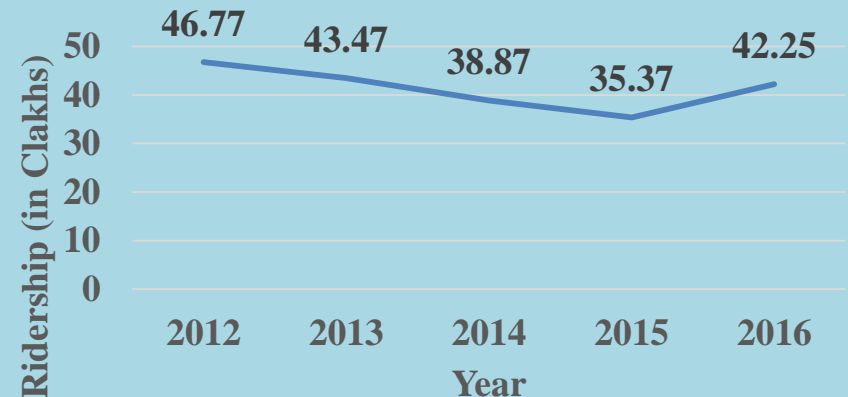- Deposit is of Rs. 50 , so initial amount totals upto Rs. 150

DTC AND DIMTS BUSES

- The DTC runs a fleet of 3,882 buses, of which 2,506 are low-floor non-AC buses, 1,275 are low-floor AC buses and 101 green standard floor buses. Besides, there are 1,672 cluster (orange) buses plying on city roads.
- Currently, bus fares in Delhi for non-AC buses are Rs 5, Rs 10 and Rs 15. There is a flat fare of Rs 5 for travel in non-AC DTC and cluster buses for travel up to five kms. Fare slab for travel in AC buses is between Rs 10 and Rs 25.
- Bus Passes are also available for students(Rs.100 per month), Normal Passes (Rs.800 per month for Non AC and Rs. 1000 Per month for AC buses)and free pass for disabled persons and senior citizens.
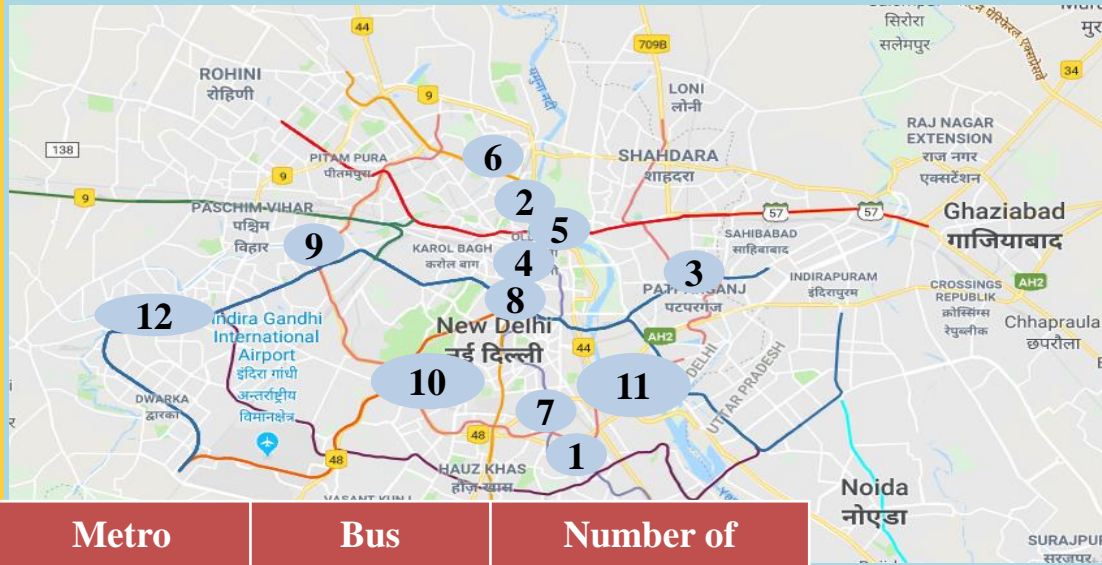
(Data as HT Times dated sept. 07, 2018)

Metro : Average Daily Ridership
Metro: Monthly Average Ridership

Ridership(in Lakhs)

27.61

28.00
27.
27.
26.
26.
25.
25.
24.
24.00

Jan-18, Feb-18, Mar-18, Apr-18, May-18, Jun-18, Jul-18, Aug-18, Sep-18, Oct-18, Nov-18, Dec-18, Jan-19

Ridership (in lakhs)

Year

(Data as per RTI filed on 27/2/19)
(Data from DMRC Website)

Bus: Average Daily Ridership

46.77	43.47	38.87	35.37	42.25

50
40
30
20
10
0

2012 2013 2014 2015 2016

Ridership (in Clakhs)

Year

(Data from The Asian age article dated Oct 19, 2017)

Primary Data Collection

S.No.	Area	Abutting Landuse
1	Nehru Place	Institutional
2	Kashmere Gate	Commercial
3	Anand Vihar	Commercial
4	New Delhi	Commercial
5	Old Delhi	Commercial
6	Delhi Vishvidhalaya	Institutional
7	Lajpat Nagar	Commercial
8	Connaught Place	Commercial
9	Rajauri	Commercial
10	Durgabhai Deshmukh	Institutional
11	Hazarat Nizammuddin	Commercial
	Dwarka Mor	Residential

Metro	Bus	Number of samples collected
Captive	X	200
Captive	Captive	100
Captive	Choice	50
Choice	Captive	50
Choice	X	50
Choice	Choice	50
X	Captive	200
X	Choice	50

Metro	Bus
Cash	Cash
Cash	DTC pass
Cash	Card
Card	Cash
Card	DTC pass
Card	Card

Data was collected from different activity places having different landuse so to have a rich mix of characters of different commuters.

Different samples were collected for different set of commuters as per the frequency of there travelling through different mode.

# Data Analysis: Revealed Preference: Captive Riders

Bus
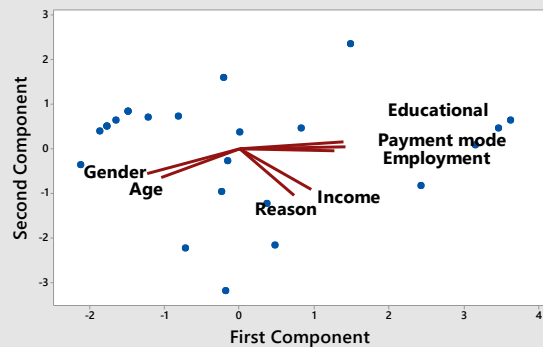
Variable	PC1	PC2
Age	-0.337	-0.397
Gender	-0.398	-0.343
Educational Level	0.456	0.029
Employment Status	0.447	0.099
Income Level	0.31	-0.558
Payment mode	0.41	-0.015
Reason	0.235	-0.634

Total Cumulative variance(>60%)	67.5%
Kaiser-Meyer-Olkin Measure of Sampling Adequacy(>0.5)	0.558

Income and Reason for not using the card in bus are related.

Metro
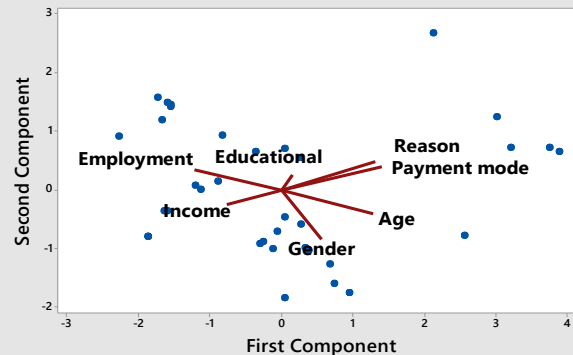
Variable	PC1	PC2	PC3
Age	0.463	-0.333	0.197
Gender	0.202	-0.678	-0.176
Educational Level	0.055	0.218	0.862
Employment Status	-0.436	0.286	-0.272
Income Level	-0.276	-0.208	0.256
Payment mode	0.504	0.323	-0.146
Reason	0.471	0.391	-0.163

Total Cumulative variance(>60%)	73%
Kaiser-Meyer-Olkin Measure of Sampling Adequacy(>0.5)	0.576

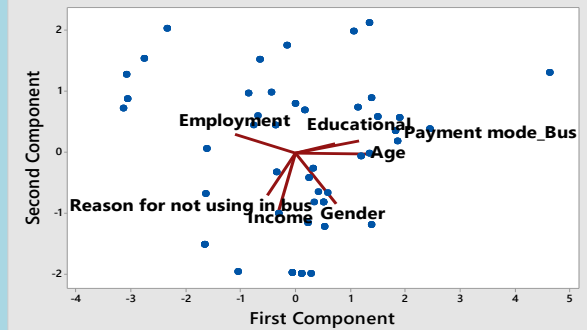**Mode and Reason for not using the card in bus are related.**

Bus + Metro

Variable	PC1	PC2	PC3
Age	0.572	-0.016	0.074
Gender	0.301	-0.565	-0.231
Educational Level	0.475	0.133	0.017
Employment Status	-0.456	0.198	-0.529
Income Level	-0.123	-0.629	-0.36
Payment mode	0.296	0.099	-0.599
Reason for not using the card in bus	-0.214	-0.467	0.416

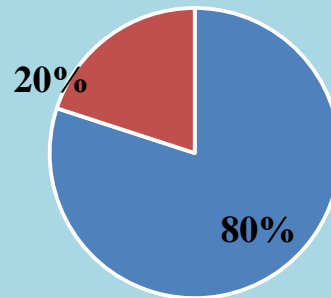|	
Total Cumulative variance(>60%)	75.4%
Kaiser-Meyer-Olkin Measure of Sampling Adequacy(>0.5)	0.61

Income and Reason for not using the card in bus are related.

Data Analysis: Revealed Preference: Captive Riders

Bus

15% 2%
35% 48%
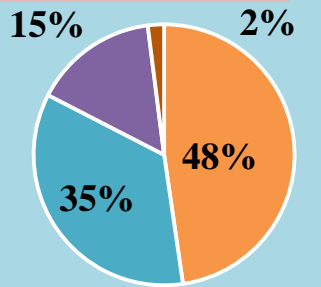
- High Deposit Money
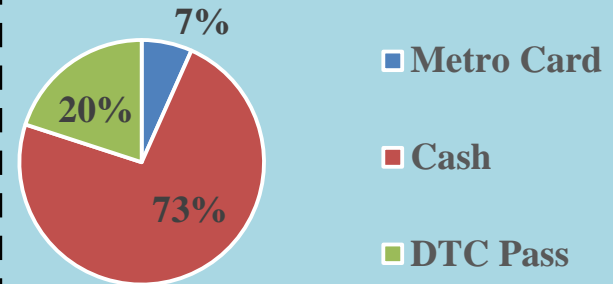- Pass is Cheaper
- Lack of Awareness
- Topping Up Card is difficult

Metro

20%
80%

- Not enough cash to recharge it today
- Fear of loosing the card

Bus + Metro

Payment Mode For Bus Trip

7%
20%
73%

- Metro Card
- Cash
- DTC Pass

33% 19%

- Pass is more cheaper
- Lack of

Mode/Income	2-3 Lakhs Per Annum	3-6 Lakhs Per Annum	6-9 Lakhs Per Annum	12 and above Lakhs Per Annum
DTC Pass	Pass is cheaper: 100%	Pass is cheaper: 71% Lack of Awareness: 29%	Pass is cheaper: 100%	Pass is cheaper: 100%
Cash	Topping Up card is a difficult as no facility is available: 44% Machine hangs: 33% Lack of Awareness: 22%	Topping Up card is a difficult as no facility is available: 25% Machine hangs:50% Lack of Awareness: 25%	Machine hangs:60% Lack of Awareness: 40%	Machine hangs:67% Lack of Awareness: 33%

not using the card in bus are related.

Income and Reason for not using the card in bus are related.
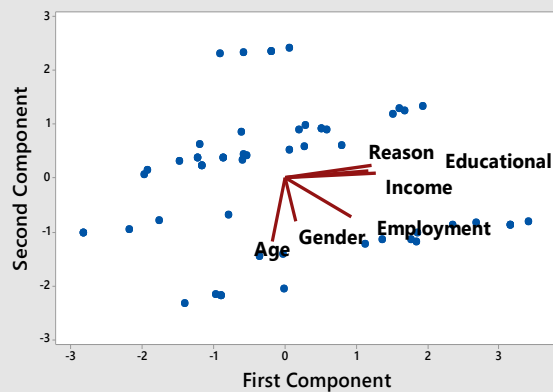
Data Analysis: Revealed Preference: Choice Riders

Non- Daily Bus Users

Daily Metro Users

Cash	64%
Metro card	27%
DTC Pass	9%

Reason for not using the Card

- Pass is more cheaper — 13%
- Lack of awareness — 25%
- Machine Hangs — 62%

Not using metro

100% using Cash as the payment mode in Bus

Income / Reason	High Deposit Money	Money gets locked up and we cannot use it at other things	Lack of awareness	Machine Hangs	Fear of loosing the card	Topping up card is a difficulty
0-1LPA	40%	40%	20%	-	-	-
1-2LPA	33%	42%	25%	-	-	-
2-3LPA	33%	67%	-	-	-	-
3-6 LPA	-	50%	25%	13%	13%	
6-9 LPA	-	42%	8%	25%	8%	17%
9-12 LPA	-	-	20%	40%		40%

Non- Daily Metro Users

Daily Bus Users

Not using Bus

Cash	28%
Metro card	72%

Payment Mode

Percentage of Commuters

- Cash
- Metro card
- DTC Pass

Bus (Captive): Cash 46%, Metro card 16%, DTC Pass 38%
Metro (Non-daily): Cash 50%, Metro card 50%

Payment Mode Vs Frequency of Travel

Reason for not using the card in bus
- Pass is cheaper: 35%
- Machine Hangs: 29%
- High deposit money: 26%
- Lack of awareness: 10%

Reason for not using card in metro
- High deposit money: 40%

Once in a week: Cash 91%, Metro Card 9%
Twice in a month: Cash 44%, Metro Card 56%
Once in a month: Cash 78%, Metro Card 22%

- Cash
- Metro Card

Data Analysis: Revealed Preference

Rank	Metro Captive Riders	Mean Score
1	Boarding Time Difference	1.70
2	Fare	1.81
3	Elimination of Change	3.34
4	Less communication with staff	3.72
5	Incentives	4.43

➢ Significance is less than 0.005

Fare	Boarding Time Difference	.482
Fare	Incentives	.000
Fare	Less communication with staff	.000
Fare	Elimination of Change	.000
Boarding Time Difference	Incentives	.000
Boarding Time Difference	Less communication with staff	.000
Boarding Time Difference	Elimination of Change	.000
Incentives	Less communication with staff	.000
Incentives	Elimination of Change	.003
Less communication with staff	Elimination of Change	.013

In this case fare and boarding time difference stands at the same place for commuters or both the benefits attract commuters are at the same pace. Similarly, less communication with staff and elimination of Change problem stands at the same pace.
But on the other hand, there is a vast difference between incentives and the other benefits. This indicates that commuters today are receiving low or no incentive benefits.

Calculate the Mean Ranks by Friedman Test

Check the significance (less than 0.05)

Make the pairs of different attributes and run Post hoc test (Wilcoxon signed rank tests)
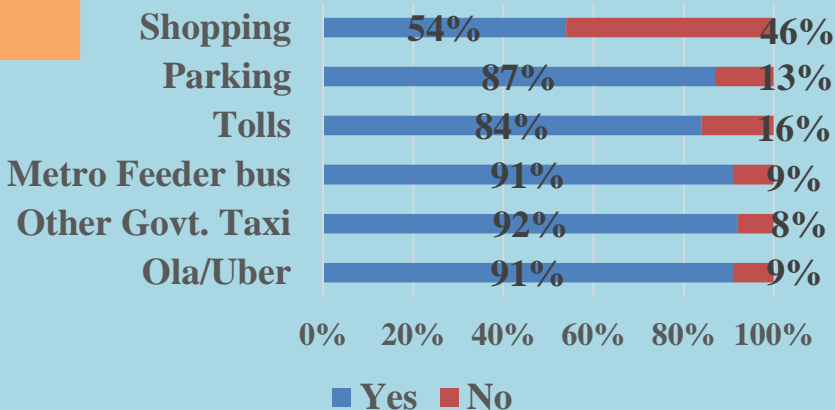
Use the Bonferroni adjustment (0.05/Number if pairs = 0.005)
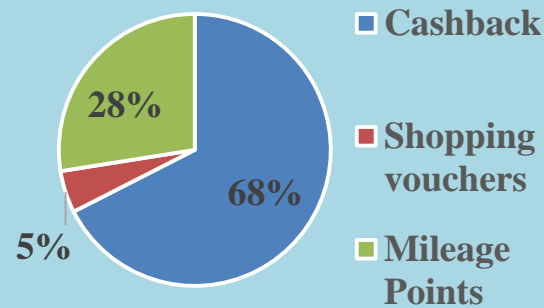
Check the statistically significance of the result

Data Analysis: Stated Preference

Extension of services

Multifunctionality of Card

Category	Yes	No
Shopping	54%	46%
Parking	87%	13%
Tolls	84%	16%
Metro Feeder bus	91%	9%
Other Govt. Taxi	92%	8%
Ola/Uber	91%	9%

0% 20% 40% 60% 80% 100%

■ Yes ■ No

Payment Mode Shift

Modes

- **Bus**
  - **Cash to Card**
  - **Pass to Card**
- **Metro**
  - **Cash to Card**

Incentives

- Cashback — 68%
- Shopping vouchers — 5%
- Mileage Points — 28%

- Multifunctionality of card
- Incentives
- Multiple Recharge options
- Reduction in deposit money

Scenarios Generated:

Orthogonal Analysis of the Design of experiments fetched these 8 scenarios of four different attributes with two levels each.
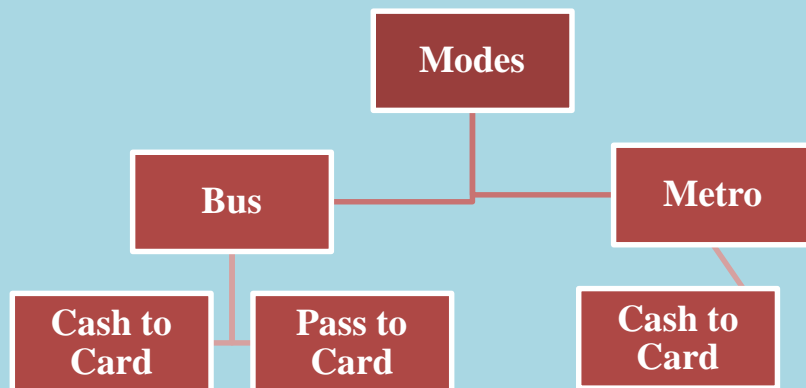
Users were willing to use the metro card in other modes also.

Users preferred to get incentives in the form of Cashback.

80% of the users showed positive response regarding multiple recharge facility.

Around 76% of the users were not willing to attach their metro card to bank. Yet another 24% were willing to attach their cards to bank.

1.   **Deposit Money**
- **Rs.150**
- **Rs.120**

2. **Multifunctionality of the Card: Yes / No**

3. **Multiple Recharge Options : Yes / No**

4. **Incentives : Yes / No**

Data Analysis: Stated Preference

Metro Users: Cash to Card

Willingness to shift :
- Fare is 10%less
- Elimination of Change problem

85% of the users show willingness to shit.

Utilities

Attributes and Levels		Utility Estimate
Incentives	No	-.996
	Yes	.996
Multifunctionality	No	-.854
	Yes	.854
Multiple recharge options	No	-.796
	Yes	.796
Initial Deposit Money	150	0.000
	120	-.467
Constant		4.733

Averaged Importance Score

Incentives	34
Multifunctionality	27
Multiple Recharge Options	26
Deposit Money	13
Multiple Recharge Options	24
Incentives	14

- Run the Conjoint Analysis in the on the ranks given by users in SPSS with the help of syntax
- More the Utility of the level more is it's liking by the user and hence more is the importance score of the attribute
  attribute

Correlations

	Value	Sig.
Pearson's R	.879	.002
Kendall's tau	.786	.003
Kendall's tau	.546	.031

Check the Correlation value it should be above 0.5
Check the significance (less than 0.05)
Check the significance (less than 0.05)

Hence, it is found that deposit money is of least important parameter for the metro users.
As the importance score for the incentives is high and so is it's utility value.

Scenario	Initial Deposit	Multifunctionality	Multiple recharge facility	Incentive	Estimated Utility Value	Exponential Value	% shift against all scenarios
1	120	Yes	No	Yes	5.32	204.5	9%
2	150	No	No	Yes	4.08	59.1	3%
3	150	Yes	Yes	No	5.38	218.7	9%
4	120	Yes	No	No	3.33	27.9	2%
5	150	Yes	Yes	Yes	7.38	1602.3	67%
6	120	No	Yes	Yes	5.20	182.0	8%
7	120	No	Yes	No	3.21	24.8	1%
8	150	No	No	No	2.08	8.1	1%

Economic Analysis

Ridership

Card users — Cash users

Willingness to shift to card

Actually shifted users (As from probability)

Boarding time difference — Fare savings — Initial Deposits
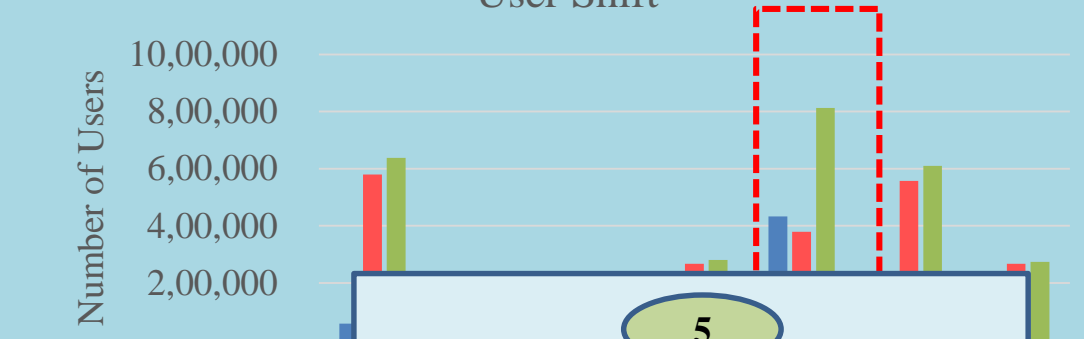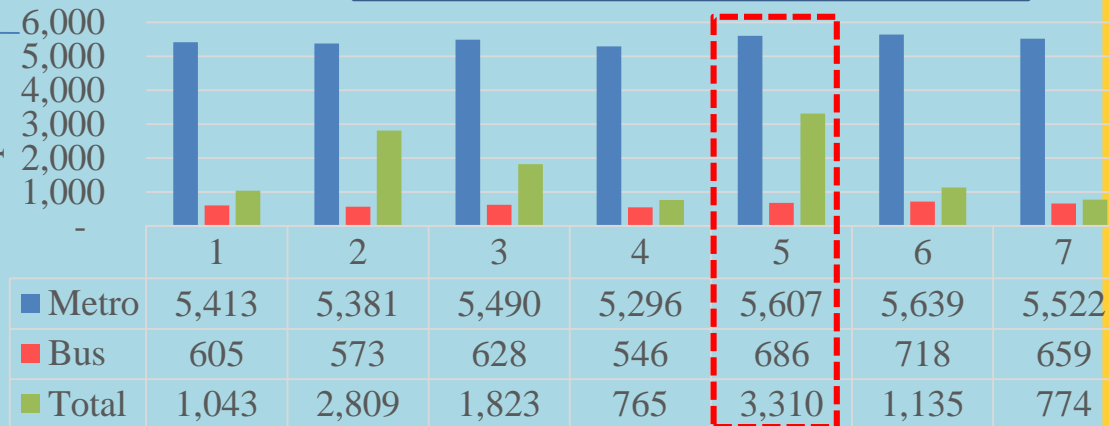
Recharge Time Consumed

Incentives

Fare savings + Boarding time difference + Incentives − Deposits + Recharge Time Consumed

User Shift

5

Initial Deposit Money: Rs. 150
Multifunctionality : Yes
Multiple Recharge Facility: Yes
Incentive: Yes

Number of Users (y-axis): 10,00,000 / 8,00,000 / 6,00,000 / 4,00,000 / 2,00,000 / -

Rs. per Year (y-axis): 6,000 / 5,000 / 4,000 / 3,000 / 2,000 / 1,000 / -

	1	2	3	4	5	6	7
Metro	5,413	5,381	5,490	5,296	5,607	5,639	5,522
Bus	605	573	628	546	686	718	659
Total	1,043	2,809	1,823	765	3,310	1,135	774

■ Metro   ■ Bus   ■ Total

Benefits to operators

Operational Benefits

Ticket Counters

Wages of workers

Logistics involved in Cash Collection

Ticket Vending Machine

Reduction in People approaching TVM by 59% Therefore, No further need to invest in huge capital amount in TVMs. Increase will be in service time.

Reduction in People approaching Ticket Counters by 62%. Therefore, Counters can be removed. This will incur wage savings.

Currently, DMRC is spending estimated 5 crores per month on wages of these employees.

- ➢ **Logistics Cost savings**
- ➢ **Wage savings**
- ➢ **No need of huge capital investments in terms of vending machines**
- ➢ **Increase efficiency of the system**

Recommendations

Multifunctionality

Multiple Recharge Facility

Incentives

A way Forward

- ➢ The **next model could be that bank debit card/credit card** could be used as a transit card. But as we noticed **76% of the users were not ready to link their transit cards to bank. Research in security is needed to win users confidence.**
- ➢ One might work as what will be the **breakeven point for the authorities so involved.** Concessions given to different users can also be worked out.
- ➢ Therefore, it paves the way to introduce the **integrated fare structure among different modes available** in the urban transport and share of the input and output cost that follows.