



Analysis of Metro rail Project selection Bias with Principal-Agent Model

A case of Delhi, Bangalore, Mumbai, Jaipur and Chennai

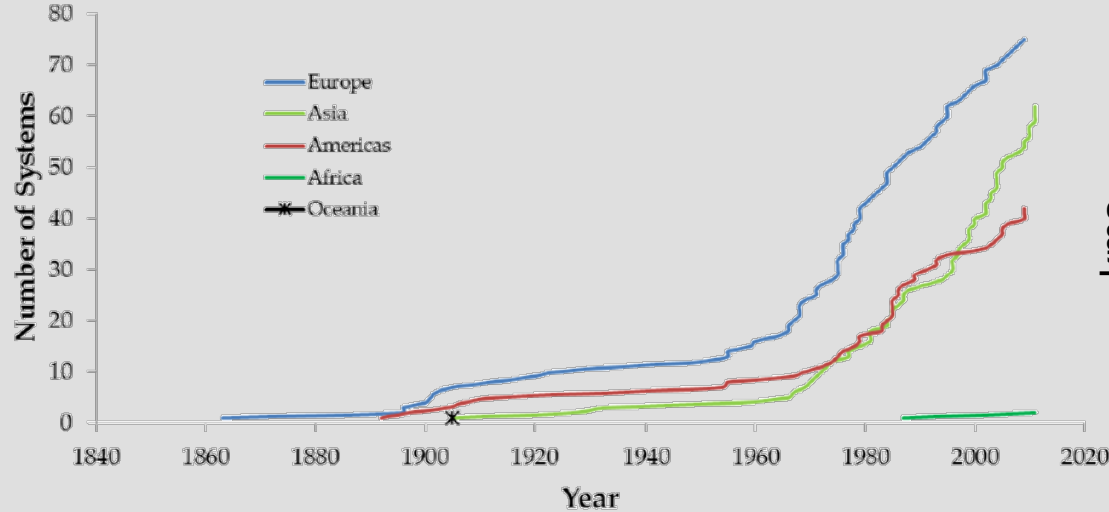


Vinod Rathod

Background

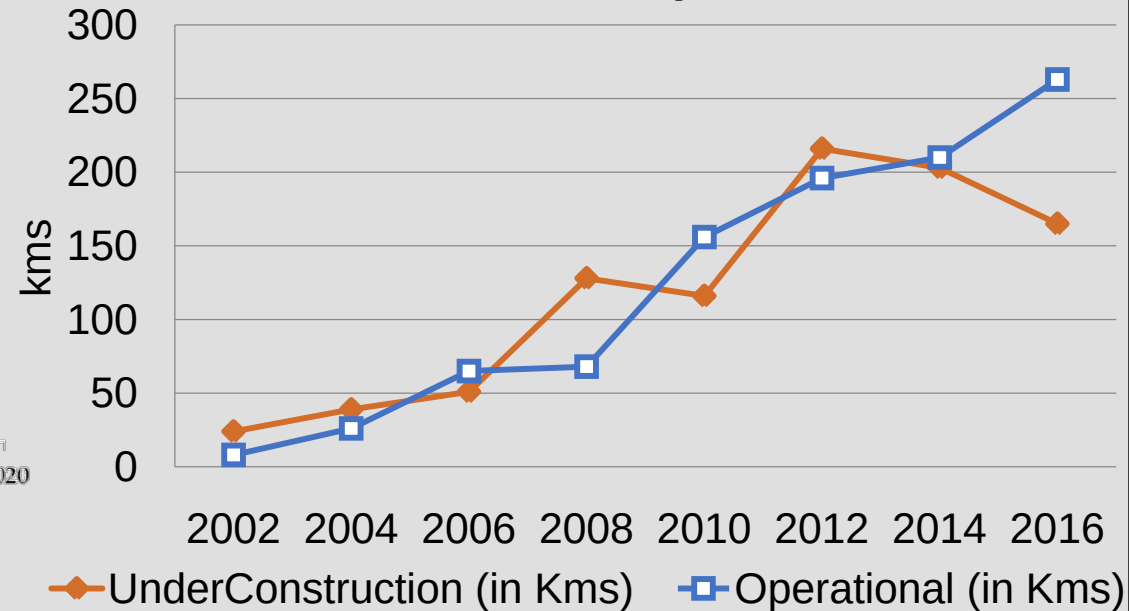
- Urban Metro Projects have proven to be very useful in decongesting large cities.
- **148 cities** around the world had Metro System.
- In World Metro systems carry **150 million** passengers per day.
- In India, many cities are now considering the **Metro system as an alternative**
- The **12th fifth year plan** Urban Transport group has recommended, Metro is only one of the Options for decongestion.

Growth of Metro rail system



(Canavan, 2015)

Growth of Metro rail system in India



Background

- Metro rail Transit is attached with the **High capital and operating costs**. It found that most of the metro systems around the world are not financially viable.
- Public investment in rail transit has long been **controversial** (Wenling, 2006)
- **Failures of rail projects to materialize the targeted performance** in terms of ridership speed, operating costs, and development benefits, on which grounds they had been justified (Pickrell, 1989)
- Anticipated **project objectives are moderately** met but at **very high costs**.
- **Under-investment** on low-cost and more cost-effective transit alternatives, such as the conventional bus or Bus Rapid Transit (BRT), because resources are often allocated to light rail investments. (Wenling, 2006)

Need of Study

India's great Metro-Rail opportunity

The impact of the Delhi Metro has not been lost on policy makers and now metro-rail projects dot various cities

Amit Bhandari | Indiaspend.org
January 20, 2015 Last Updated at 13:26 IST



When you think [oil](#) fields, you usually think oil-rigs in the deep sea or a forest of rigs in the desert.

What does not come to mind is a bustling metropolis.

But if you believe the adage that “a penny saved is a penny earned”, the [Delhi Metro](#) doubles up as an [oil](#)

NATION, CURRENT AFFAIRS

Rs 100 crore loss for Delhi Metro despite ridership

DC | SANJAY KAW

Published Oct 13, 2014, 12:16 pm IST

Updated Jan 10, 2016, 8:38 am IST



Most of the DMRC projects are running behind the schedule



BangaloreMirror

MUMBAI MIRROR | AHMEDABAD MIRROR | PUNE MIRROR

METRO RAIL | ON LOSS, BUT ON TRACK

By Suchith Kidiyoor, Bangalore Mirror Bureau | Oct 12, 2016, 02:00 AM IST



The word “loss” instantly disaster for any ongoing project. So too with the Bangalore (BMRC's) five-year-old metro, which has incurred a loss of Rs 60.3 crore – almost double its previous year's loss.

But considering these early losses from a range of nagging factors, the city's metro rail service is still on track.

News » City News » Jaipur News » Jaipur Metro witnesses steep fall in ridership

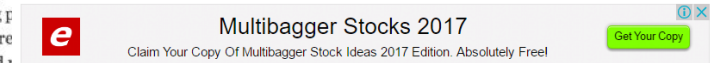
Jaipur Metro witnesses steep fall in ridership

TNN | Updated: Feb 1, 2017, 09:53 AM IST

Mumbai Metro faces financial crisis

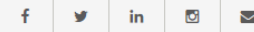
Bets big on the HC order on fare revision & assistance from Maharashtra Govt

Sanjay Jog | Mumbai
June 29, 2016 Last Updated at 00:33 IST



Reliance Infrastructure-owned [Mumbai Metro](#) One Pvt Ltd (MMOPL), which on June 8 completed two years of operations of the 11.4 km Versova-Andheri-Ghatkopar metro line, faces a major financial crunch due to a pending high court order on fare revision and lack of commitment from the [Maharashtra government](#) assistance. This is despite a 10 per cent rise in the average weekday ridership to 3,08,000 in June 2016 from 2,79,000 in June 2015.

THE HINDU



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CHENNAI

Chennai Metro Rail sees fall in passenger footfall



Why Such a huge Capital Intensive Project ???



Analysis of Metro Rail Project Selection Bias with Principal agent Problem model

- ❖ To Analyze performance of metro rail project investments in terms of objective, ridership, revenue, and capital cost
- ❖ To identifying the causes of metro rail forecast errors and its sources
- ❖ Test the hypothesis through the application of the Principal-agent problem to Metro rail funding process

Aim

Objective

Methodology

1.Literature Review

Reviewing papers and Metro rail policy

Identification of Metro rail Operation Indicators

Decision Making Concept (Economic Behaviour Theory)

How to measure Public Transport Operation Performance ?

What Sampling method can be used?

What is impact of principal-agent problem on decision making process.

2.Need for the study

Identification of Metro rail failure reason

Identification of different actor (s) role in decision process.

3.Process

1.Data Collection (Metro DPRs & Policy documents)
2.Converting raw data into graphs

1.Delhphi Method
2.Interview with Experts
3.Schedule of Survey and Analyzing the questionnaire prepared

Data

Primary

Secondary

Methodology

4.Comparative Analysis

5.Conclusion & Suggestion

Preliminary analysis of data

Study the Operation Performance of
Metro rail Project (Forecast versus
Actual

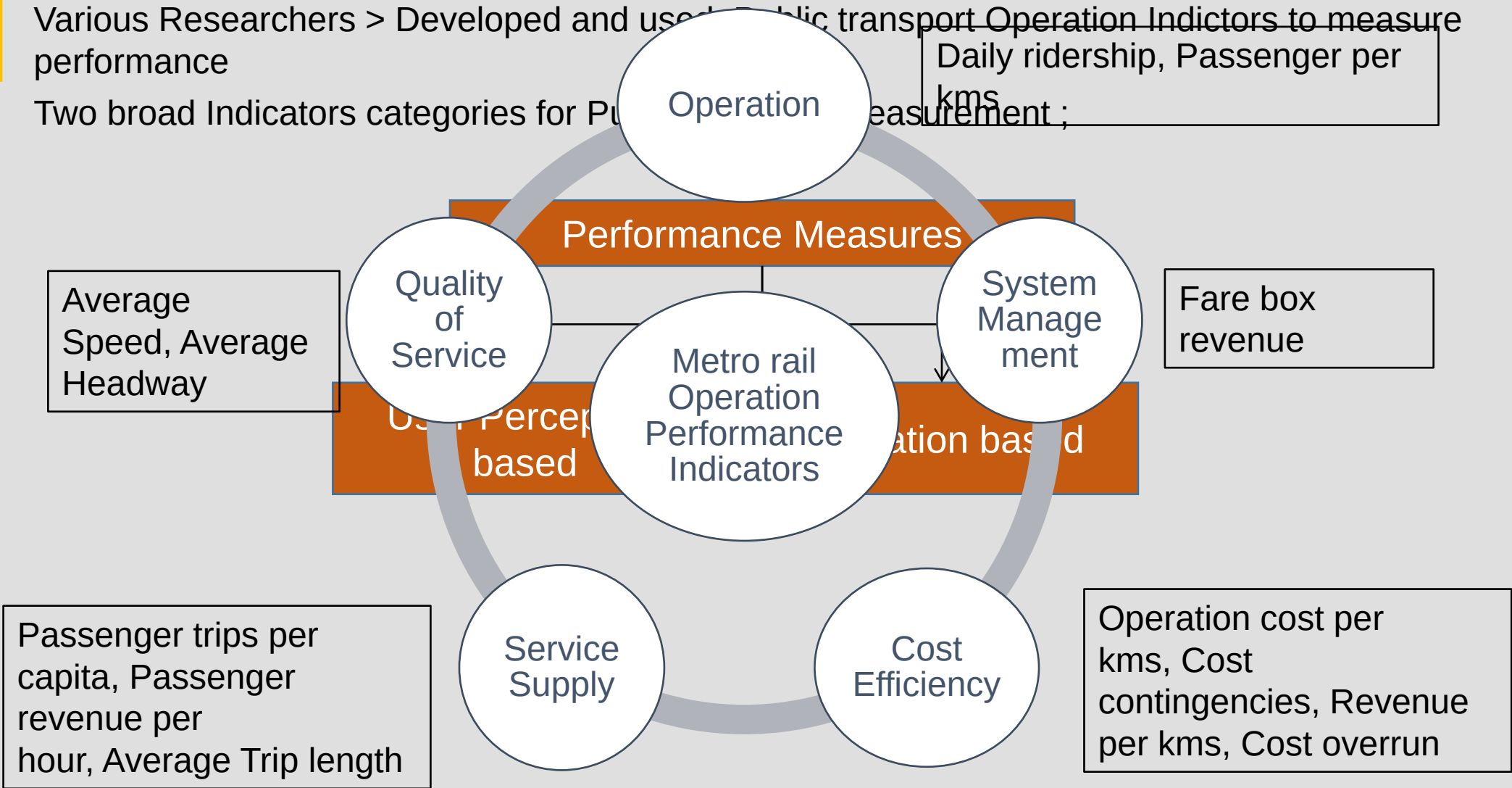
Study the forecast errors

Application of Principal-agent model on
Metro rail funding policy

Literature Review

Various Researchers > Developed and used Public transport Operation Indictors to measure performance

Two broad Indicators categories for Public transport measurement ;



Literature Review

Forecast errors in metro rail are attached as followed

- Ridership: In Baltimore and Portland, it ranges from 66% to 85% below the original forecasted. (Don H, 1990)
- Capital Outlay: The project cost at Pittsburgh's light rail project were actually 11% below as their actual forecast value, whereas Sacramento's light rail and Miami metro project is 13% and 106% less than forecast. (Don H, 1990)
- Operating Expenses: In case of Buffo's Light rail (12%), Washington (200%), Atlanta (200%) and Miami's metro project (84%) above their foreseen level. (Don H, 1990)
- Cost-Effectiveness: In case of Zeytinburnu-Şişli Tramway cost effectiveness 58% higher than estimated. (Ozge, 2011).
- Contingency allowance to cover cost escalation: The contingency allowance for -rail project is ranging from 5 to 10% of estimated project costs. (Don H, 1990)

Application of Organisation theories on Research

Theory	Strengths (Regarding the Research Problem)	Weaknesses (Regarding the Research Problem)
Game Theory	Mathematical derivation of recommendations regarding interdependent choices and actions,	• Highly restricted viewpoint requires scenario modelling
Institutional Theory	Defines coercive, normative and mimetic pressures that lead to the sustainable behaviour of organizations	• Lack of understanding of non-conforming organizational behaviour • provides no explanations for incentive mechanism design
Network Theory	Descriptive character that may be used to map the interplay between MoUD and Local authority regarding sustainable funding mechanisms	• Lack of theoretical foundation and explanatory power of mapped interplay
Resource-Based View	Insights into the capabilities and resources that are required to achieve competitive.	• Lack of explanatory power regarding incentive mechanisms

Theory	Strengths (Regarding the Research Problem)	Weaknesses (Regarding the Research Problem)
Transaction Cost Economics	Concerns internal and external costs that result from the sustainable behaviour of local authority	• Dominance of transaction costs • No explanations for incentive mechanism design
Principal-Agent Theory / Agency Theory	• Structure of the design of incentive mechanisms regarding information asymmetries and agency problems (ex-ante and ex-post contract) • Derivation of recommendations for incentive design with respect to the suggestions of agency theory	• Restricted view on static MoUD and local authority relationships terminate of efficiency objectives and opportunistic behaviour that may conflict with legitimacy-driven sustainable behaviour
Strategic Choice Theory	Insights into the development of interorganizational sustainability strategies	• Dominance of strategic decisions • No explanations for incentive mechanism design
Stakeholder Theory	Explanatory theory that maps the interplay of markets and resources , explains sustainable behaviour as a consequence of stakeholder pressures	No explanations for incentive mechanism design

Analysis

1st Objective: To Analyze performance of metro rail project investments in terms of objective, ridership, revenue, and capital cost

Case study : Delhi,Bangalore,Mumbai ,Jaipur and Chennai

2nd Objective :To identifying the causes of metro rail forecast errors and its sources

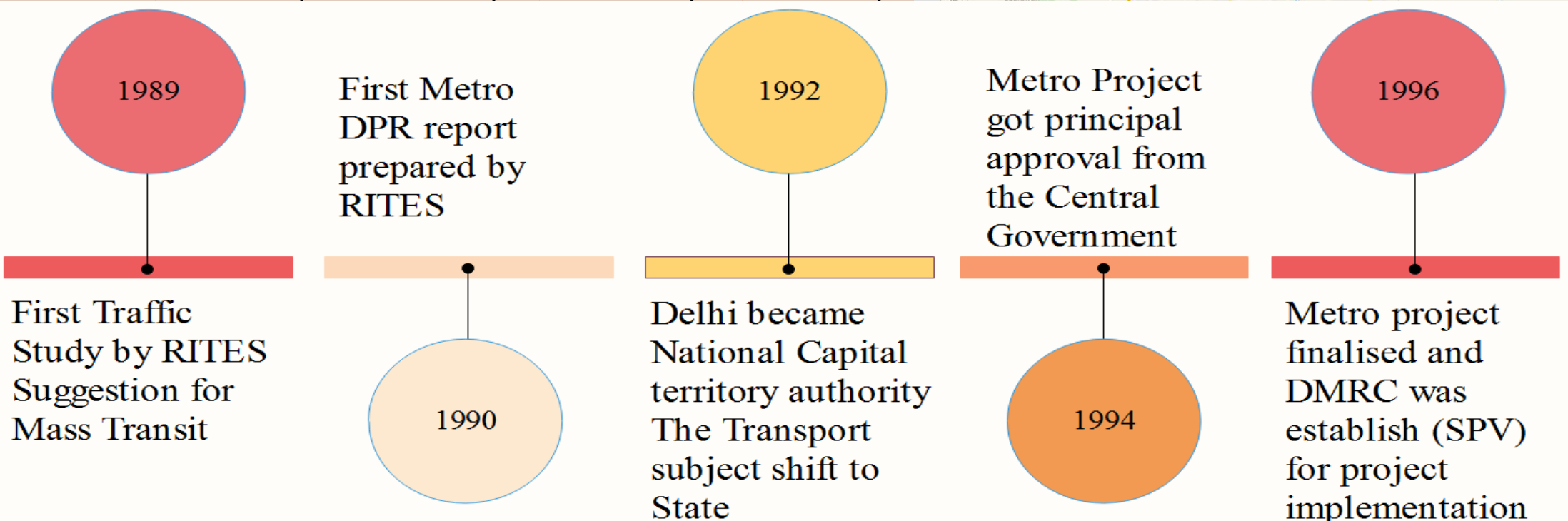
Delhi Metro rail project-Brief

- Delhi MRTS objective was **provide non-polluting, efficient and affordable rail based** MRTS ,duly integrated with other modes of Transport

➤ The first section of phase 1 was opened in 2002 and Currently 193.20 Km (in 2016) of Metro

Metro Network

Year 2016 2021 2026 2031
Phase 1 Ridership Ridership Ridership Ridership



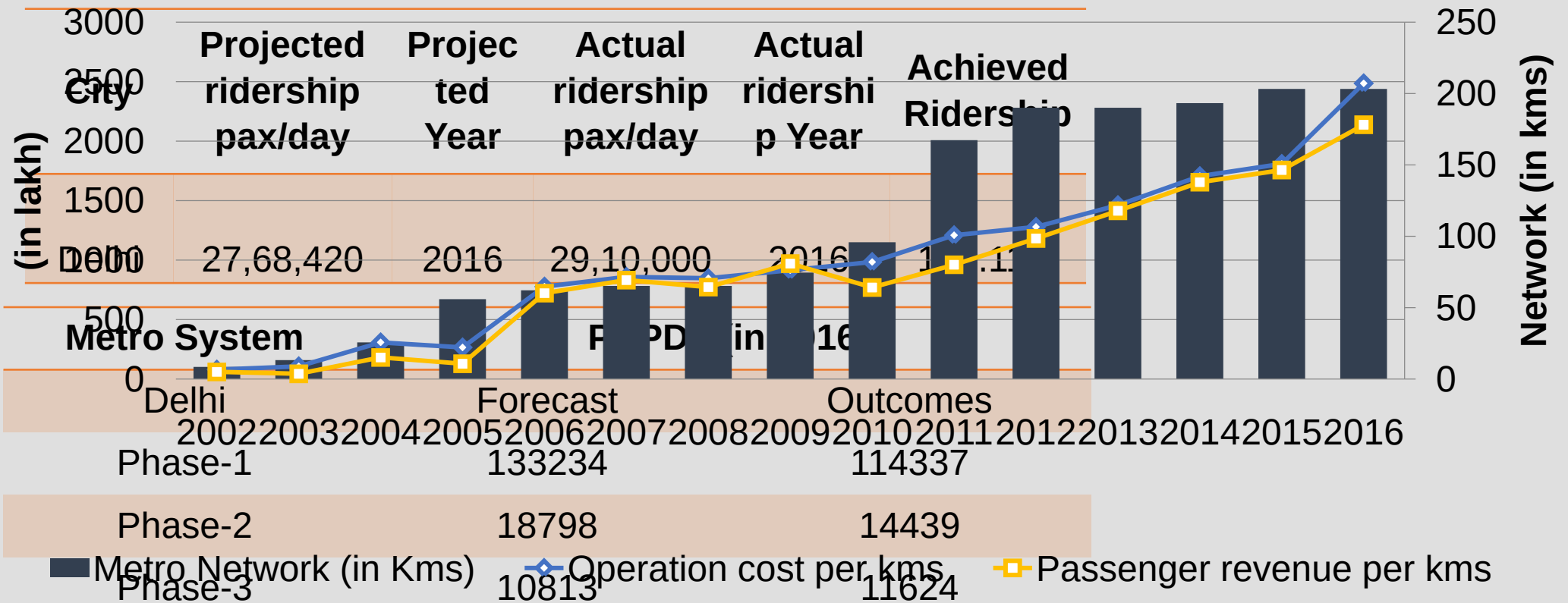
Phase-2	Green Line	18.5
	Violet Line	23.4
Phase-3	Orange Line (Airport Express)	22.7
	Total	193.2



Phase 1 | Phase 2 | Phase 3 | Phase 4

Source: The Metro Guys

Forecast versus Actual Ridership



Estimate versus Actual project cost

Operating Cost

• Operating cost per kms is **Rs in 24.86 Cr** and Revenue per kms is **Rs.21.37 Cr.**

• Average per kms **fare Rs . 0.5**

Project Cost

• Estimate Cost for Phase 1 (as per 2011) : **Rs. 4859 Cr.**

• Actual completion cost of Phase-1 (as per 2011) : **Rs.10571 (118% difference)**

Delhi Phase-1

Delhi Phase-2

Delhi Phase-3

◆ Estimate Cost per kms(In Cr)

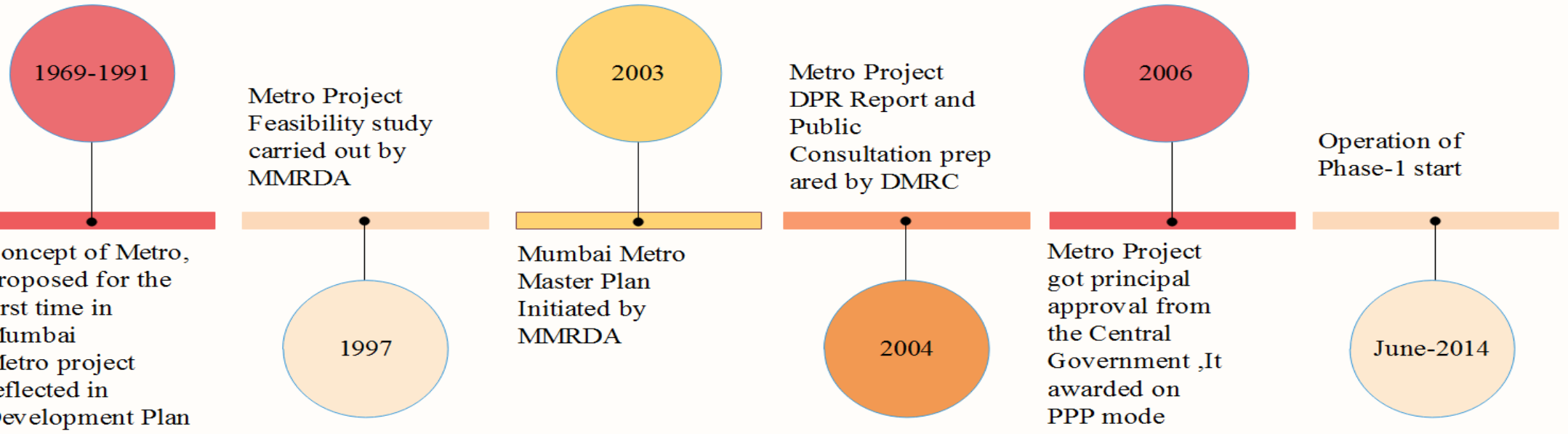
■ Actual Cost per kms(In Cr)

Mumbai Metro rail project-Brief

The objective of the metro system was **to achieve affordable, safe and environmentally free public transport system.**

The first section of phase-1 was opened in 2014 and Currently 11.4

Year	Daily Ridership	Hourly Ridership	PHPDT
2009	175016	28004	17256

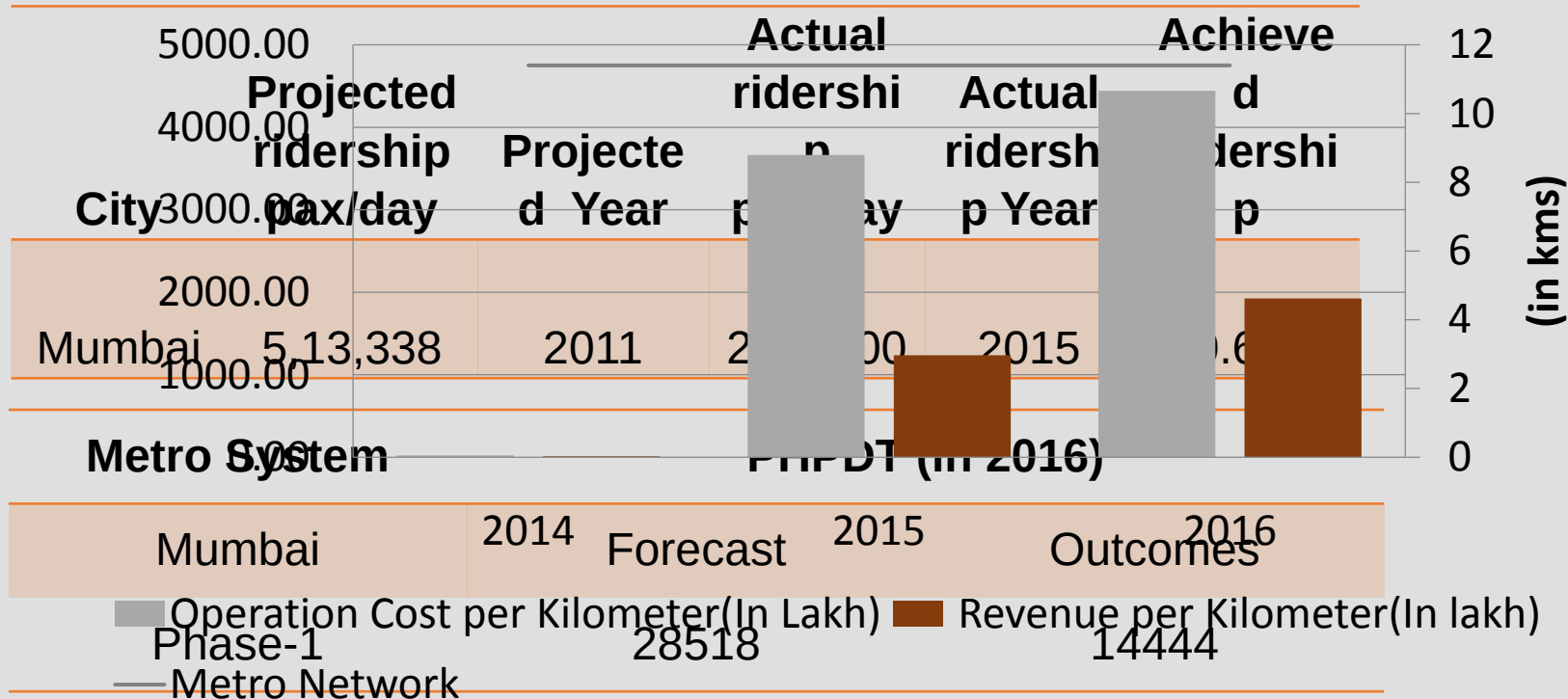


Charkop-Dahisar (east)	7.5
Ghatkopar-Mulund	12.4
BKC to kanjurmarg via Airport	19.5
Andheri(east)-Dahisar(east)	18
Hutatma Chowk-Ghatkopar	21.8
Sewri-Prabhadevi	3.5



Line -1 | Line -2 | Line-3 | Line -4 | Line -5 |
Line -6 | Line -7

Opex versus Revenue Ridership



Operating Cost

- **Annual earning cross Rs 135 Cr. still in loss** (opex per kms Rs **44.41** Cr and Revenue per kms Rs **19.25** Cr)
- **Fuel and Electricity** cost is higher compare to other metro system
- Average per kms fare Rs.3.9

Project Cost

- Estimate Cost for Line-1 (as per 2011) : Rs.**2356 Cr.**
- Actual Completion of Line-1 (as per 2011) : Rs.**4151 Cr. (85% difference)**

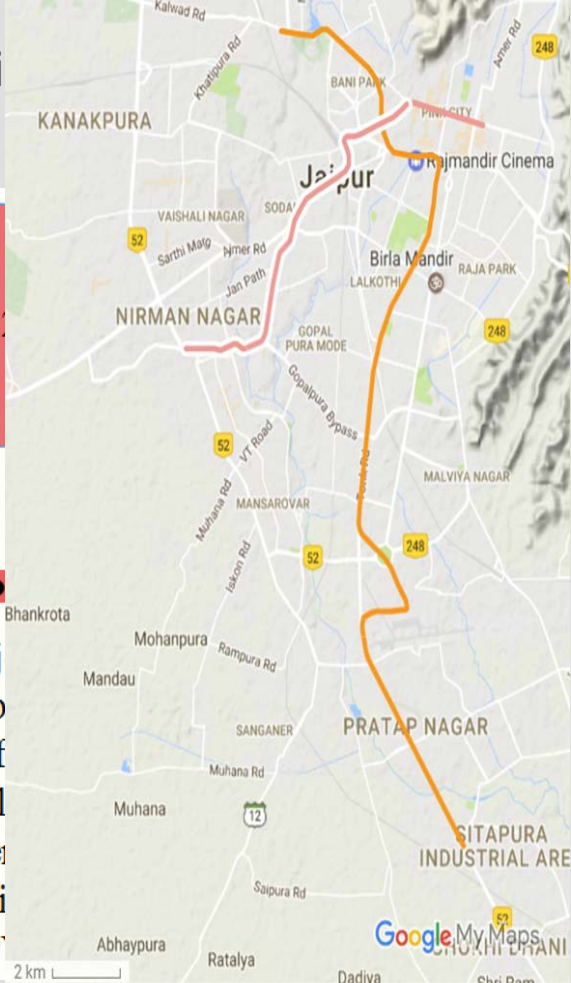
Jaipur Metro rail project-Brief

➤ The objective for metro system is **to provide fast, safe and haste free movement of the public in the city.**

➤ The first section of phase-1 was opened in 2015 and Currently 9.3 Km (i network is operating

Metro Network

Year	Corridor	Sectional Load(PHPD T)	Daily Riders (in lakhs)	
2014	Mansarovar-Badi Chaupar	11264	2.1	
2021	Mansarovar-Badi Chaupar	16376	2.9	
2031	Mansarovar-Badi Chaupar	27750	4.2	
2014	Sitapura Industrial Area-Ambabari	12901	3.2	
2021	Sitapura Industrial Area-Ambabari	18683	4.9	
2031	Sitapura Industrial Area-Ambabari	22429	6.8	
Description		Underground (km)	Elevated (km)	Total (km)
E-W Mansarovar to Badi Chaupar		2.789	9.278	12.067
Sitapura Industrial Area to Ambabari		5.095	18.004	23.099



Phase-1
Phase -2 c

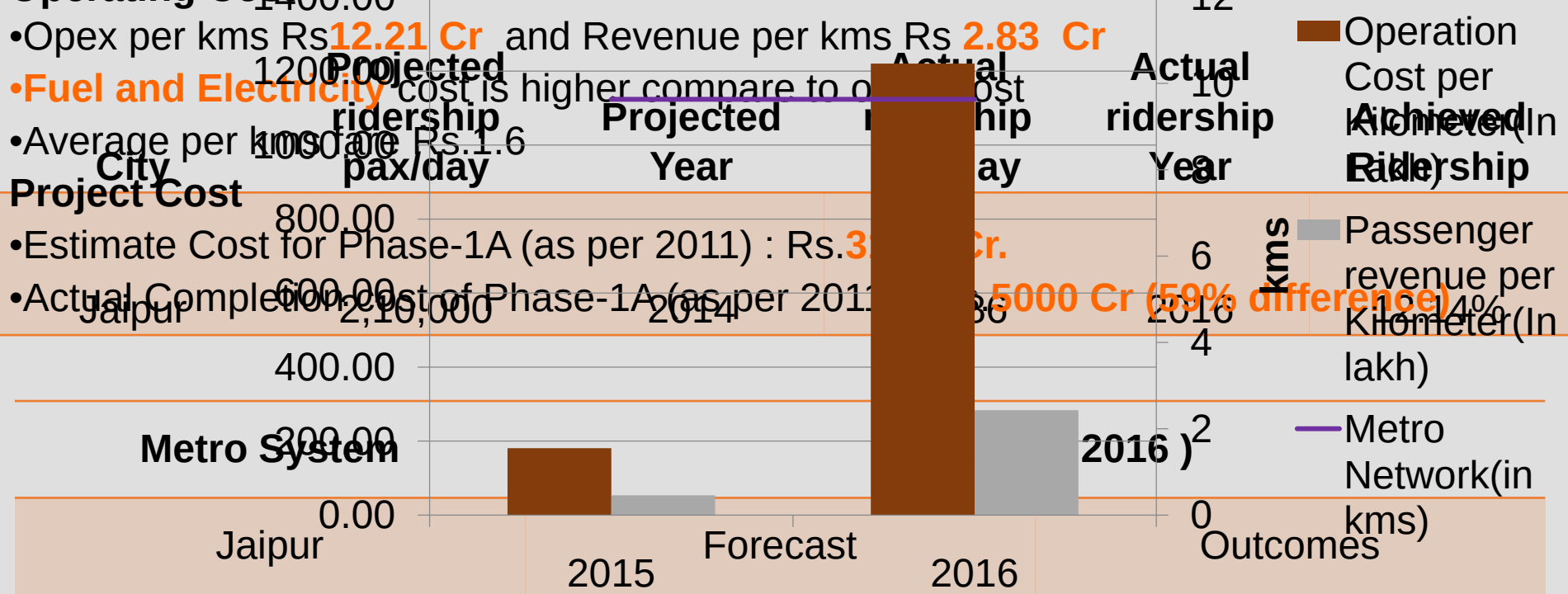
Operating Cost

- Opex per kms Rs **12.21 Cr**
- **Fuel and Electricity** cost is higher compare to other cities
- Average per kms fare Rs.1.6

Project Cost

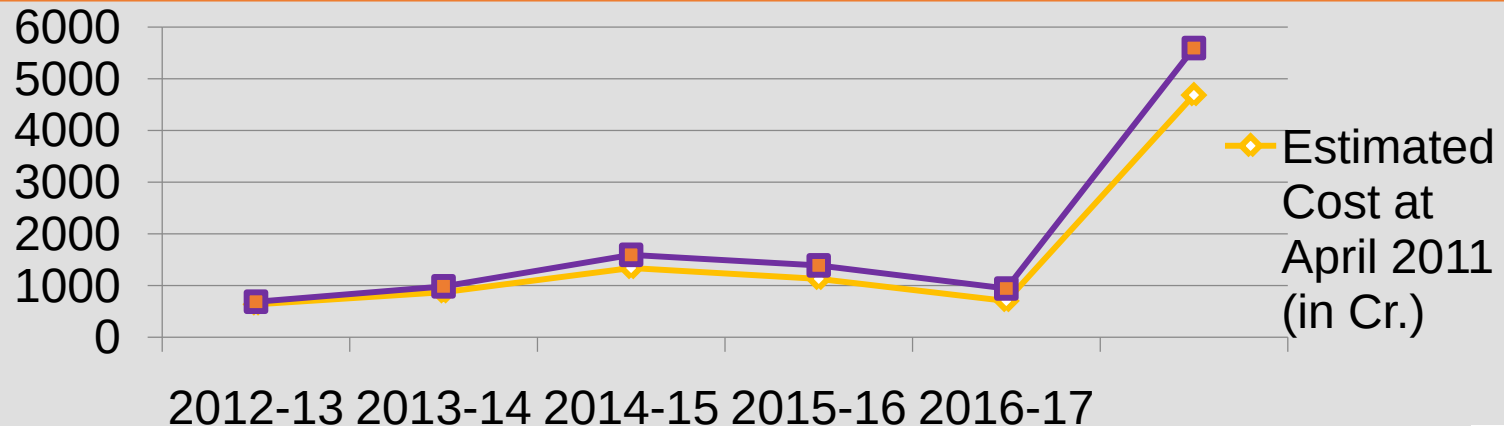
- Estimate Cost for Phase-1A (as per 2011) : Rs. **3000 Cr.**
- Actual Completed cost of Phase-1A (as per 2016) : **5000 Cr (59% difference)**

Operation versus Revenue



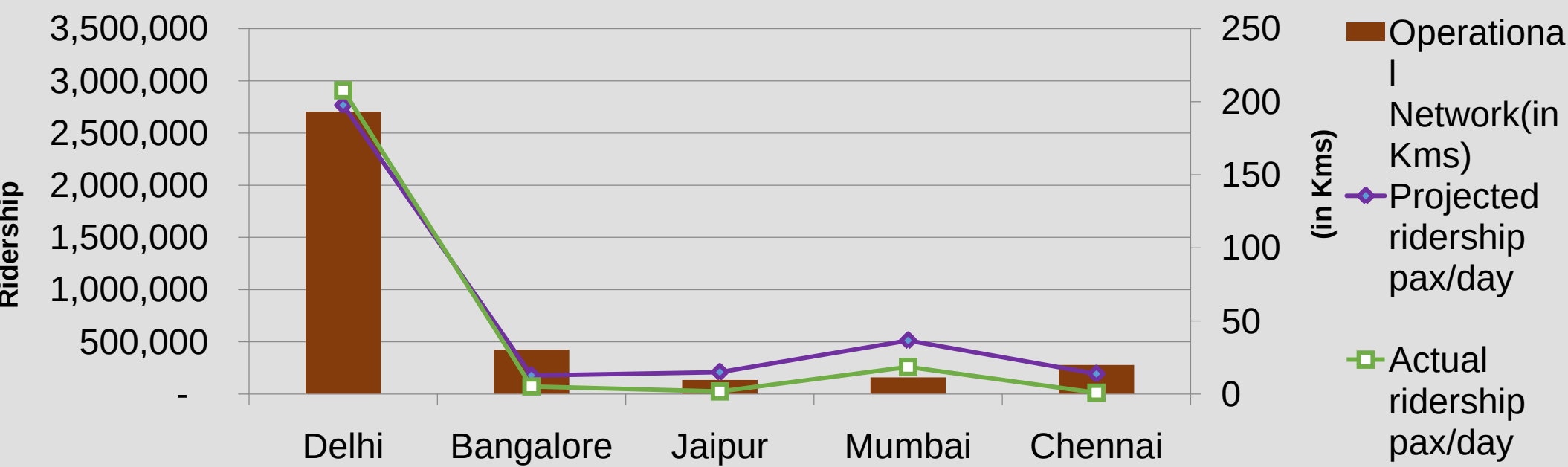
Phase-1

Estimate versus Actual project cost

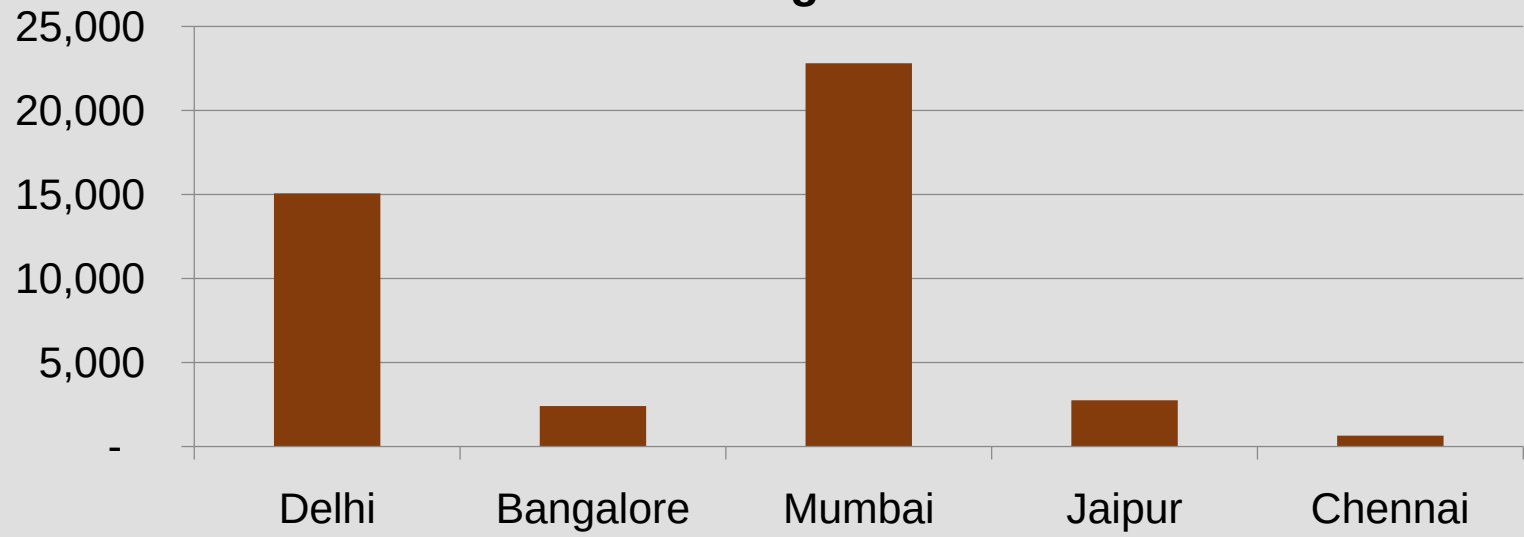


Comparison of five metro rail performance

Forecast versus Actual ridership



Passenger Per km

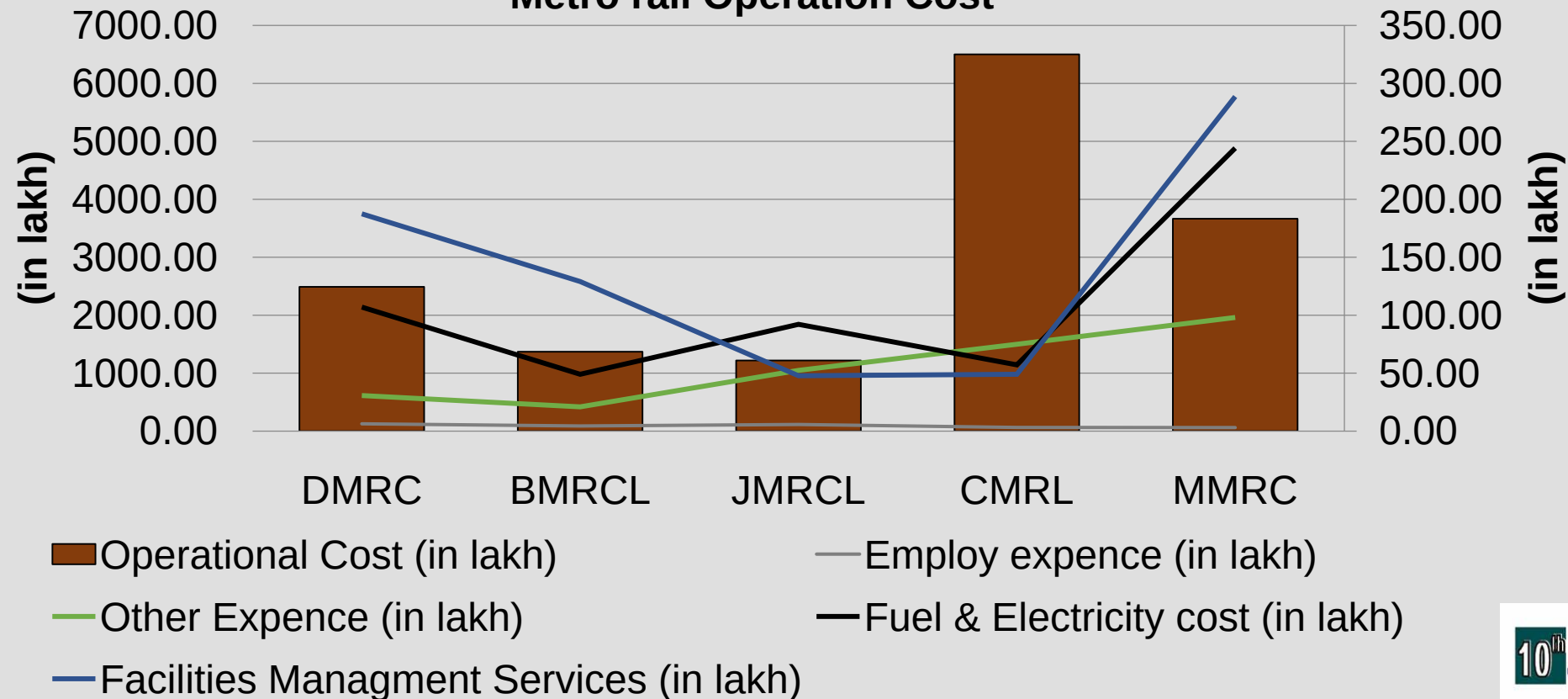


Comparison of five metro rail performance

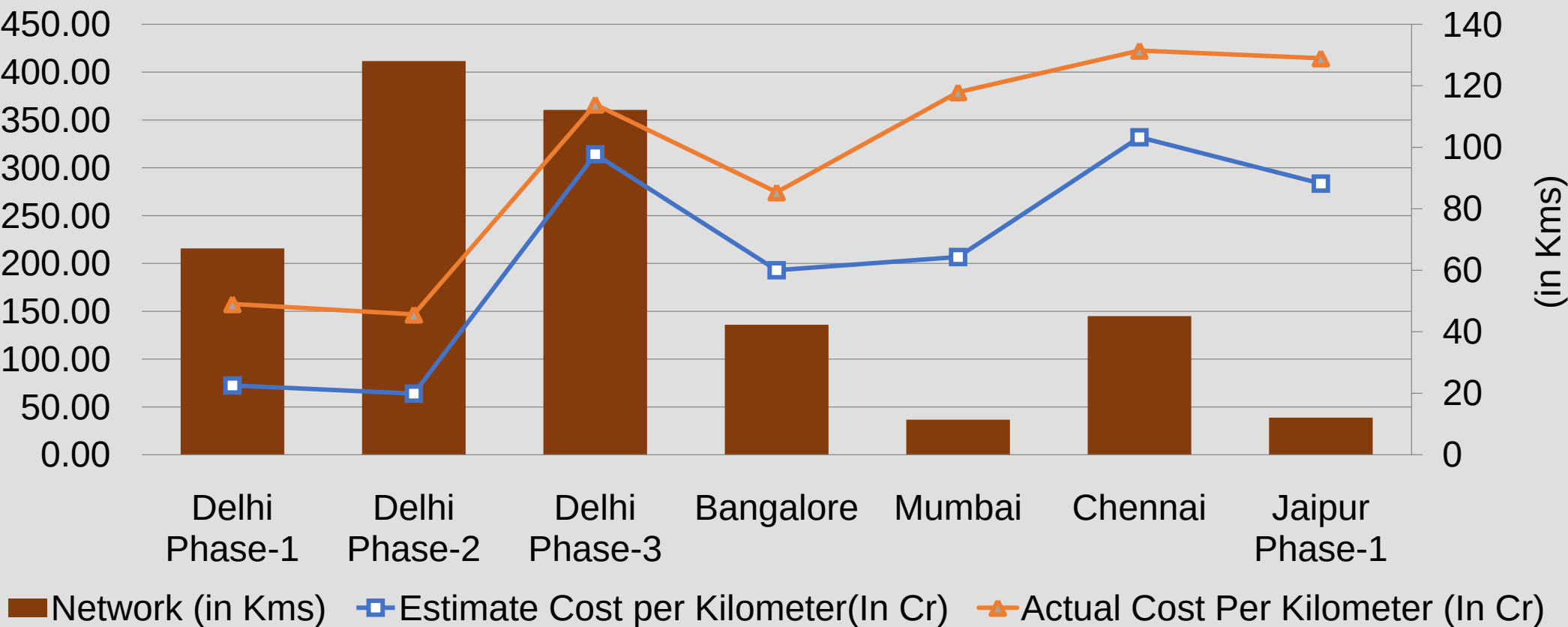
Ridership Comparison

Project (Country)	No. of projects (N)	Quartiles (25/50/75%)	Average difference (%)	Standard deviation
India (2016)	5	-49/-88/-93	-58.56	39.34
Europe (2007)	6	-29/-4/45	-20.7	77.30
North America (2007)	10	-69/-63/-53	-60.0	17.0

Metro rail Operation Cost



Comparison of five metro rail performance



Project (Country)	No. of projects (N)	Quartiles (25/50/75%)	Average difference (%)	Standard deviation
India (2016)	5	33/51/70	30.21	25.18
Europe (2008)	6	39/45/57	43.30	21.30
North America (2008)	10	33/42/54	35.80	30.40

3rd Objective: Test the hypothesis through the application of the Principal-agent problem to Metro rail funding process

Principal –Agent problem Model

Why Principal –agent model ?

➤ Structure **information asymmetries** and principal-agent problem that inherent the inter relationship between the state and the private metro rail project selection.

➤ It applied when the private information of agent creates a problem for the Principal.

What is Principal-agent problem ?

Conflict objective

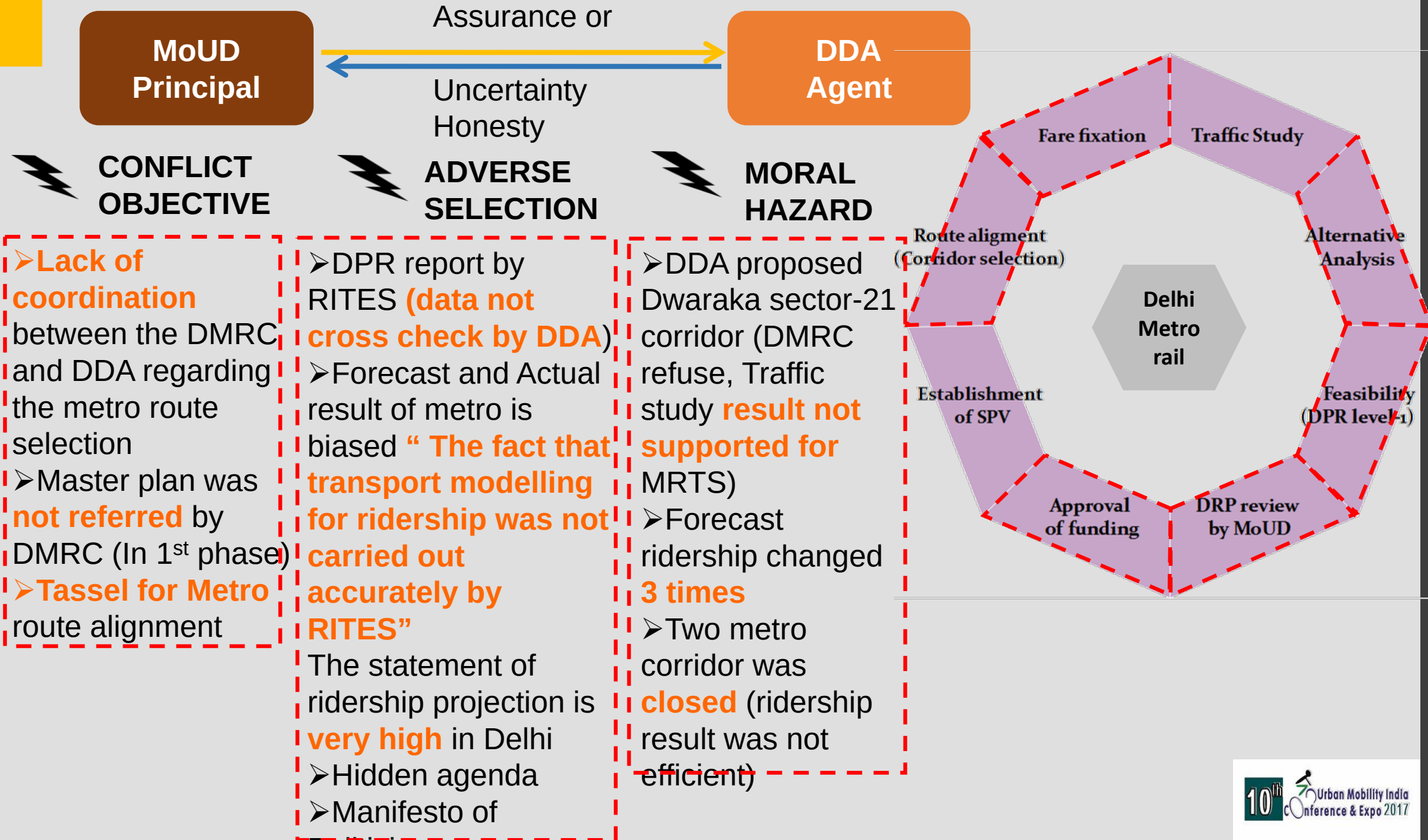
Adverse selection

Moral hazard

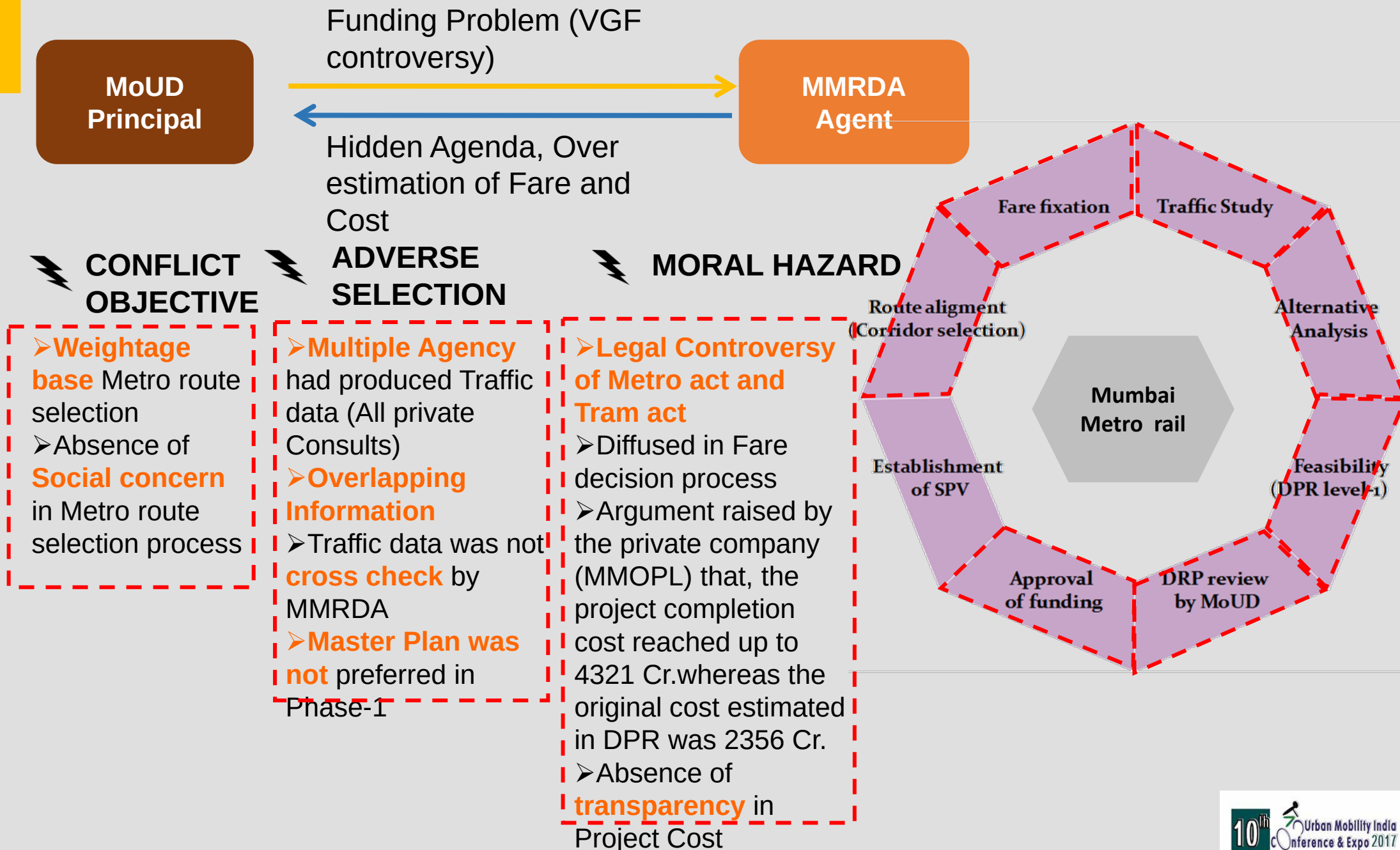
**PRINCIPAL
AGENT PROBLEMS**



Principal-agent Model-A case of Delhi Metro



Principal-agent Model-A case of Mumbai Metro



Principal-agent Model-A case of Jaipur Metro

MoUD
Principal

Controversy for
Funding



Political Pressure,
Refused for JV model

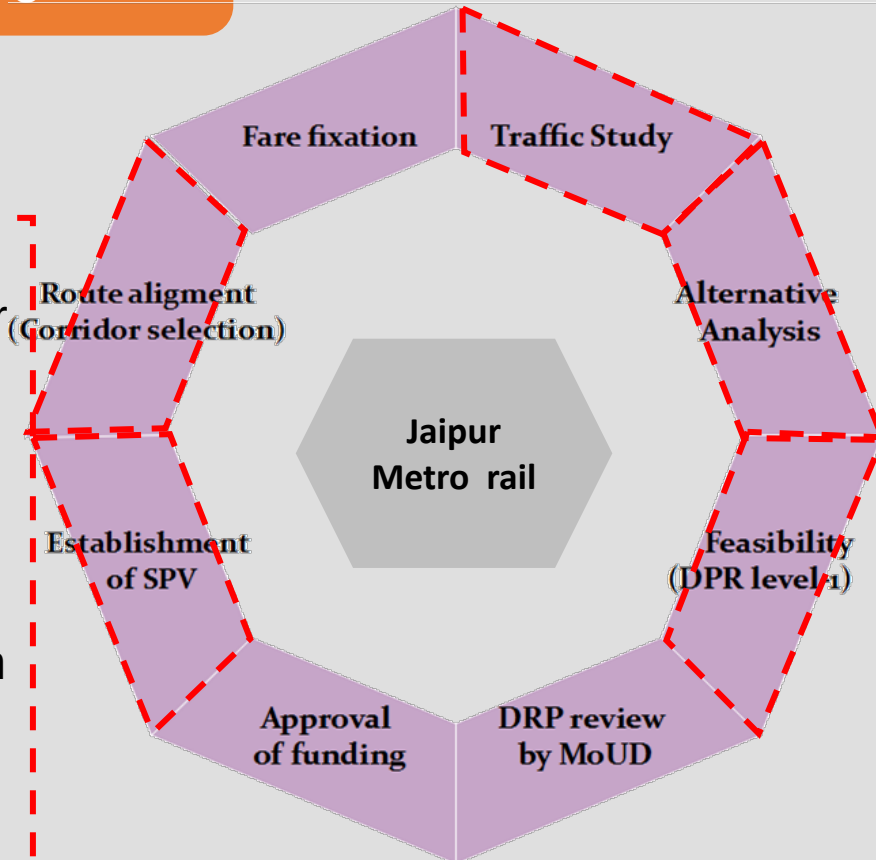
JDA
Agent

⚡ CONFLICT OBJECTIVE

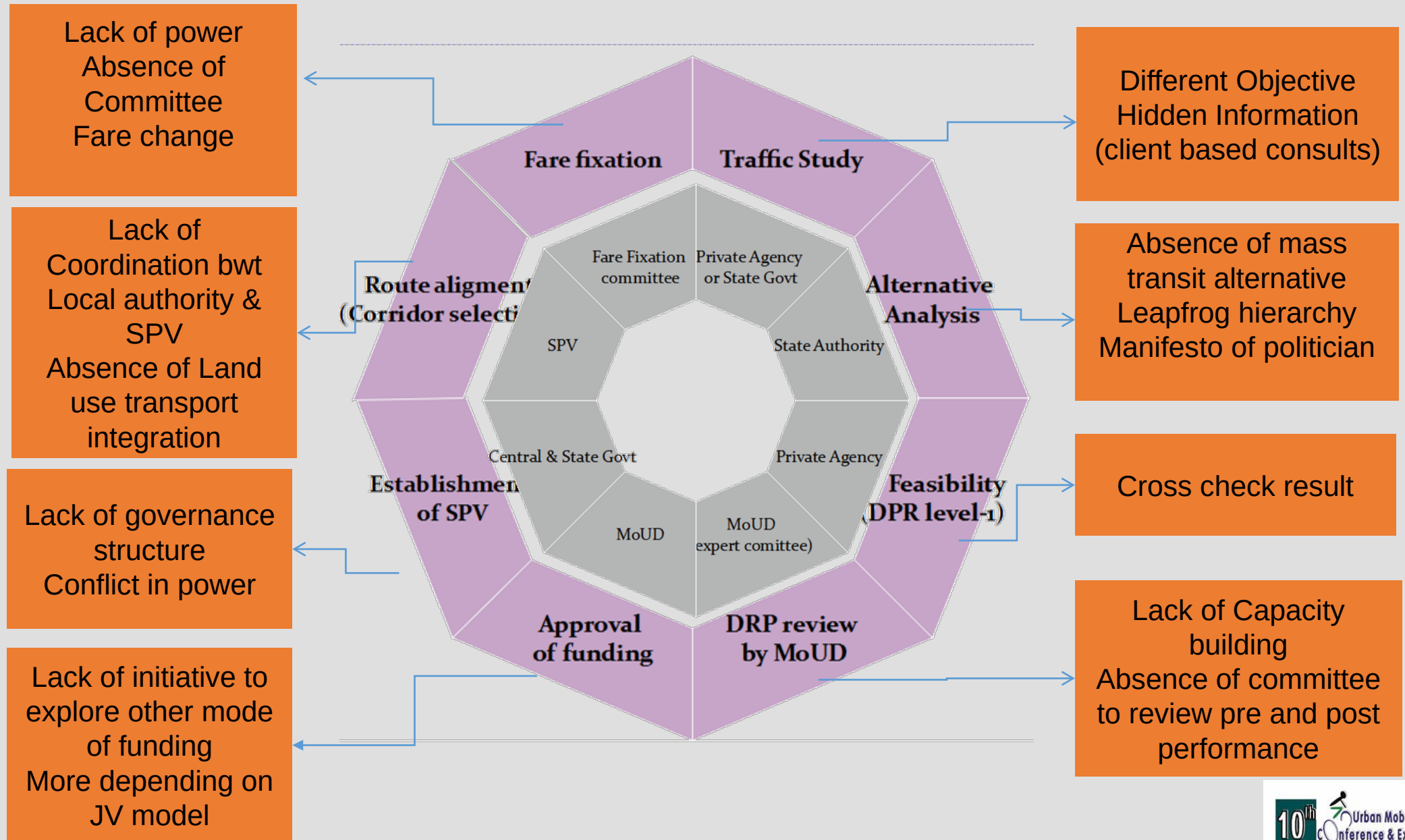
- Modern Technology for Traffic solution rather than adopting **hierarchy of Transport** mode as per requirement
- **Political promise and Biased** for Mass transit system
- **Client Based Consults**, e.g Inflated Ridership and less capital investment
- Metro board **chairmanship conflict**

⚡ ADVERSE SELECTION

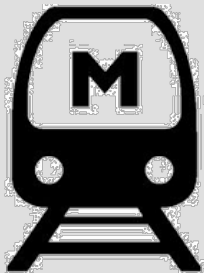
- **Absence of Alternative** Transport Plan (Prepaid by Wilbur smith Associates)
- **No coordination** between the JMRCL and JDA regarding the Metro route selection
- **No Master Plan** and **JDA involved** in MRTS route selection process
- Two **different approaches** for Traffic Management by JDA and JMRCL (Asymmetric Information) (e.g during the construction of phase-1, There are historical monuments were found while drillings. This study was not capture in DPR)



Overview of Principal agent problem



Conclusion



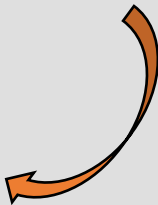
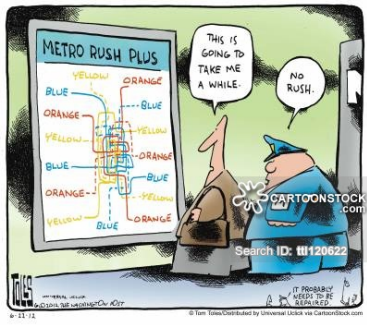
Metro Rail



Principal –Agent
Problem



Next Waiting line for Metro
Rail Project



Suggestion

Preparation of Traffic and CMP study

Design a contract in such way that the **objective of principal and agents are incorporated** while designing the funding agreement.

Identification of Mass transit

Revelation of principal; scheme should be design for the truthful information. It may **penalty or rewards rates, as per the revelation of Information**. The rewards (penalty) would be decided based on the performance.(e.g. operation

Alternative Mass transit analysis

performance)
NUTP review committee should formulate **certain indicators to evaluate mass transit option** for different size of cities.

Preparation of DPR & Review

Special committee formulate under the power of NUTP, who can analyze all report produced during the mass project selection. (Feasibility, Technical, Social & Economic, and EIA report).

Increased the **capacity building of** staff in NUTP committee.

Involved different field of **Expert in NUTP committee**.

Corridor Selection

- The MoUD (principal) need to provide **minimum level of incentives** in terms of funds .Due to minimum incentive State(agent) are willing to participated in the contract game mechanisms. The minimum incentive should be worked based on the **objective functions of State** (agents)
- If the projects are developed as state sector project MoUD may contribute by way of **grant equivalent ,as VGF in a PPP project**
- Projects which are **viable with admissible VGF without providing real estate** rights to the concessionaire may be taken under PPP.
- **Failure in awarding bid** should result in project being taken in government sector.

Establishment of SPV

- If central **projects being developed under government sector** (due to requisite autonomy in decision making) it provides, 50:50 JV .
- During shareholder agreement, **liability of GoI would be limited to equity and sub-ordinate debt agreed** at the time of formation of JV.
- JV may provide within the ambit of transparency bodies and would be audited by **Comptroller and Auditor General**
- Metro board **chairmanship should be under Central Government**

Thank You