9th Urban Mobility India Conference & Expo 2016
Planning Mobility for City's Sustainability

PRODUCTIVITY OF RAILWAY STATIONS

CASE STUDY: NEW DELHI RAILWAY STATION

By:

ROHIT ANAND

Former PG Student, Transport Planning
School of Planning and Architecture, New Delhi

Under Guidance and Co-Author:

PROF. DR. SANJAY GUPTA

Professor of Transport Planning,
School of Planning and Architecture, New Delhi

PRESENTATION STRUCTURE

- INTRODUCTION
- METHODOLOGY
- LITERATURE REVIEW
- DATA BASE
- STUDY AREA
- NEW DELHI RAILWAY STATION CHARACTERISTICS
- LEVEL OF SERVICE ASSESSMENT
- ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT
- SUMMING UP

- **INTRODUCTION**
- METHODOLOGY
- LITERATURE REVIEW
- DATA BASE
- STUDY AREA
- NEW DELHI RAILWAY STATION CHARACTERISTICS
- LEVEL OF SERVICE ASSESSMENT
- ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT
- SUMMING UP

INTRODUCTION

BACKGROUND

- Railways Stations are the **important component** in regional and city's transport system.
- Railway Stations are the **gateway into the towns** along with focal point of economic and social activities.
- Station's design reflects the **culture, historical background and life-style** of the people of that city / region.

Kings Cross Station, London, UK

Kuala Lumpur Railway Station, Malaysia

INDIAN RAILWAYS

- Caters over **800 cr passengers** and nearly **1 cr tonnes of freight** annually.
- World's largest railway networks comprising **65,808 km** length of route network and **7,112 stations** as on March 2014.
- World's 7th largest commercial or utility employer, with over **1.376 million employees** as on 2013.

Indian Railway Logo

New Delhi Railway Station

Station's Platform Area

Railway Line Tracks

INTRODUCTION

RESEARCH NEED

- Railway station **productivity assessment is critical** in improving facilities for users as well as in operations.
- Shabby and **least concerned infrastructure of Railway stations** and terminals in India.
- **Station facility audit** has been neglected. Station facilities are obsolete and needs to be upgraded.
- Most of the efforts in Indian railways are targeted towards running more trains to cater increasing demand but **improving station's environment** to cater that much of demand **is completely neglected**.
- **NTDPC report** have clearly mentioned that passenger services provided by Indian Railways are low to medium level of service & comfort with poor facilities as well as poor upkeep of stations and **recommends to redevelop stations for smooth flow and comfortable experience of passengers** as also to ensure clean and hygienic environment.

INTRODUCTION

AIM

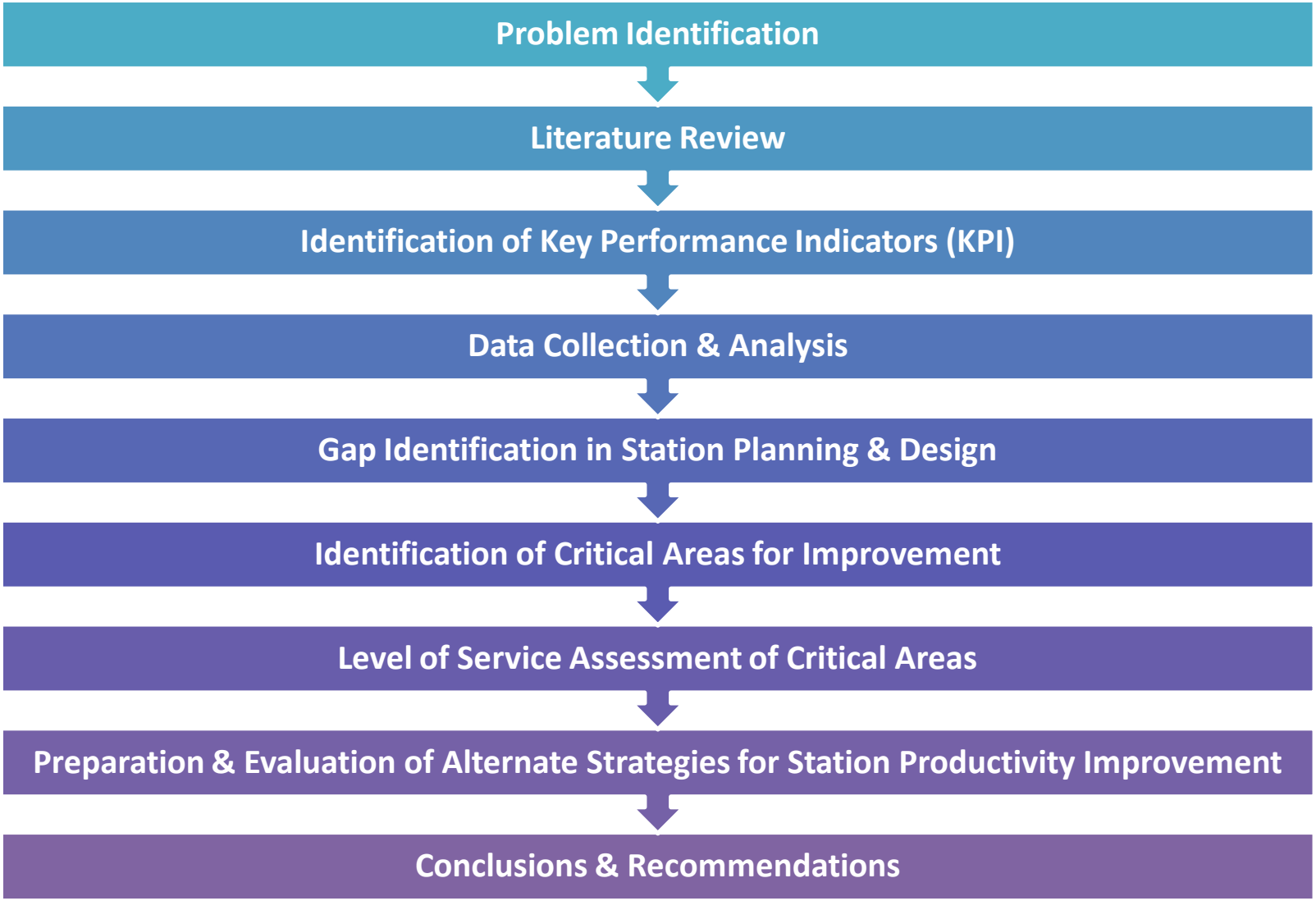
To assess the performance of Railway Stations in India and evolve alternate strategies for its improvement.

OBJECTIVES

- To understand the concept, components and planning norms of Railway Stations and its planning;
- To review approaches for measuring performance of passenger terminals and stations;
- To review global best practices for Station planning and identify performance benchmarks;
- To assess the physical and operational characteristics of Railway Stations and their relation with the station performance;
- To identify the gaps in station planning parameters and evolve/recommend appropriate planning guidelines

- INTRODUCTION
- **METHODOLOGY**
- LITERATURE REVIEW
- DATA BASE
- STUDY AREA
- NEW DELHI RAILWAY STATION CHARACTERISTICS
- LEVEL OF SERVICE ASSESSMENT
- ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT
- SUMMING UP

METHODOLOGY



- INTRODUCTION
- METHODOLOGY
- **LITERATURE REVIEW**
- DATA BASE
- STUDY AREA
- NEW DELHI RAILWAY STATION CHARACTERISTICS
- LEVEL OF SERVICE ASSESSMENT
- ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT
- SUMMING UP

LITERATURE REVIEW

FUNCTIONAL AREAS OF RAILWAY STATION

Core Area

- Focuses on processing passengers
  - Ticketing
  - Information
  - Waiting
  - Restrooms

Transition Area

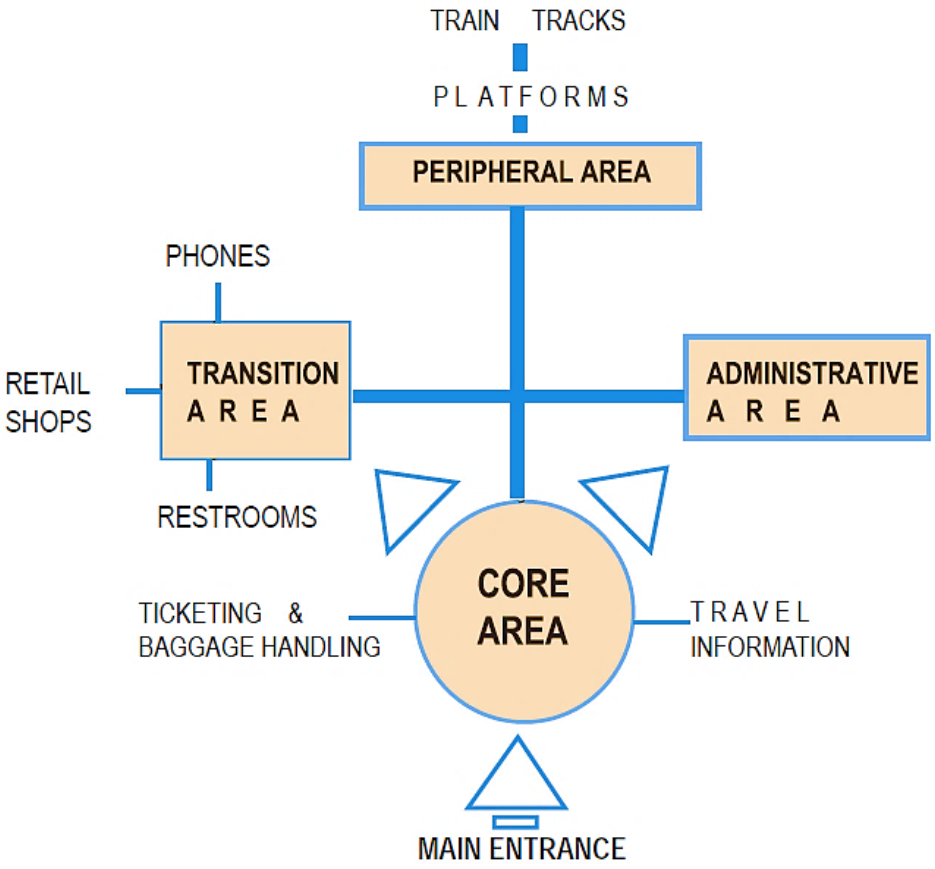
- Connect transit facilities in the core areas to the transportation modes
  - Telephones
  - Commercial Spaces

Peripheral Area

- Support circulation outside the main building
  - Platforms, Tracks
  - Vehicle service spaces

Administrative Area

- Control both traffic and station management



Flow diagram of functional elements within railway stations

Source: Paper on "Intermodal Concept in Railway Station Design" by S. Kandee

LITERATURE REVIEW

FUNCTIONAL AREAS OF RAILWAY STATION

Area/Users	Activities	Requirements
Core ⬇ Passengers Visitors Staff	• Departure - Ticket Schedule Check - Ticket Booking - Baggage Handling - Fare Collection - Gate Check-in - Security Check - Waiting • Arrivals - Meeting & Greeting - Reclaiming Baggage - Gate Check-out	• Entry - Security Check • Concourse - Info Kiosks / Help Desks - Signage's / Display Boards - Ticket Counters w/ w/o Baggage Check-ins / Ticket Vending Machines - Snack Bars / Book Stalls / AVMs • Peripheral Area Entry Gate - Automated Ticket Collectors / Staff - Waiting Area / Seating - Baggage Screening Devices • Peripheral Area Exit Gate - Meeting Point / Waiting Area / Seating - Baggage Reclaim / Holding
Peripheral ⬇ Passengers Staff	• Departing, Arriving &/or Working - Boarding / Alighting - Loading and Unloading - Maintenance	- Platforms - Tracks - Guard / Driver's Cabins - Announcers Cabin - Cargo Holding Area - Workshop or Vehicle Service Areas - Traffic Signaling Controls
Transit ⬇ Passengers Visitors Staff	• Departing, Arriving, Working &/or Visiting - Using Public Facilities - Walking to Vehicles or waiting around before boarding - Shopping or Eating	• Connecting or Circulation Areas - Public Service Facility viz. Restrooms, Public Urinals & Lockers - Amenities such as Shops, Restaurants and Snack Bars - Business Centers / Banks / ATMs
Administrative ⬇ Staff Visitors	• Working & Traffic Controlling Systems - Working - Controlling Traffic Systems and Functions in the Stations	• Offices - Management / Administration / Support Staff - Operations / Traffic Controlling - Staff Cafeteria / Restrooms

LITERATURE REVIEW

TYPE OF STATIONS

Line Stations	Terminal Stations
Transfer Stations	Inter-modal Stations

STATION COMPONENTS

The general sequence of the component spaces follows the customer's path: entry, through the control area, to the platform, and onto the train.

Entrance/Exit – Unpaid Area – Paid Area - Platform

CATEGORIES OF STATIONS FOR PROVISION OF PASSENGER AMENITIES

S.No.	Category	Criteria
1.	**A1**	Non-Suburban stations with an annual passenger earning of **more than Rs. 50 cr**
2.	**A**	Non-Suburban stations with an annual passenger earning of **Rs. 6 cr and upto Rs. 50 cr**
3.	**B**	I. Non-Suburban stations with an annual passenger earnings **between Rs. 3 cr to Rs. 6 cr** II. Stations of tourist importance, or an important junction station (to be decided by G.M.)
4.	**C**	All Suburban stations
5.	**D**	Non-Suburban stations with passenger earnings **between Rs. 1 cr and Rs. 3 cr**
6.	**E**	Non-Suburban stations with passenger earnings **less than Rs. 1 cr**
7.	**F**	Halts

Source: Indian Railway Manual for Standards and Specifications for Railway Stations (June 2009)

LITERATURE REVIEW

PLANNING AND DESIGN PRINCIPLES

Objective: Maximum Passenger Convenience with **Fast and Efficient Passenger Flow**

Design Approach and Hierarchy: should be done from whole to part:

- **Primary Order:** Describes the **creation of Station volumes** through large scale engineering. Yard alignment, no. & size of platform, size & location of concourses etc.
- **Secondary Order:** Building Components, such as detailing of concourse space, facilities of passengers, operational offices, staircases, escalators, elevators, passageway, entry, exit, roof, ceilings, walls etc.
- **Tertiary Order:** Passenger Information System, Seating, Lighting etc.

PLANNING NORMS & STANDARDS

- **Local city developmental bye-laws and master plan** shall be followed in designing the capacity of infrastructure facilities, such as building design.
- Other Codes or specifications in order of priority:
  - National Building Code (**NBC**) & **IRC** Codes,
  - Bureau of Indian Standards (**BIS**),
  - American, British and International Standards,
  - Any other.

Source: Indian Railway Manual for Standards and Specifications for Railway Stations (June 2009)

LITERATURE REVIEW

KEY PERFORMANCE INDICATORS (KPI)

- To calculate productivity of any Station / terminal in terms of its **Physical and Operational characteristics** in the most relevant Quantitative method is by **assessing the Level of Service (LOS)**, from part to whole.

- Also, according to Indian Railway manual 2009, Creation of Station Volumes by means of **number & size of platforms, size & location of concourse** etc. is the primary order for station planning & design, to fulfill their objective of **Maximum Passenger Convenience with Fast and Efficient Passenger Flow**

- **Identified Key Performance Indicators**: --- Dwell Time
  --- Level of Service (LOS)
  -- Average Passenger Space (m^2/pax)
  -- Flow Rate (pax/m/min)

DWELL TIME

- It is the Average Time a person is in a space or Process (Avg. time spent/pax.)
- As people move faster - Dwell time is shorter

LITERATURE REVIEW

LEVEL OF SERVICE (LOS)

Indian Railways follows "**J.J. Fruin's LOS Performance Standards**"

Allocated Space per Person in the Terminal Area

Terminal Area	Allocated Space (m²/passenger)					
LOS	A	B	C	D	E	F
Check-in Queue	1.71	1.53	1.35	1.17	0.99	System Breakdown
Wait / Circulate	2.61	2.25	1.8	1.44	0.99	
Hold Room	1.35	1.17	0.99	0.81	0.54	

Source: Indian Railway Manual for Standards and Specifications for Railway Stations (June 2009)

Average Flow LOS criteria for Walkway

LOS	Average Space (m²/p)	Flow Rate (p/min/m)
A	> 5.6	0 – 16
B	3.7 – 5.6	16 – 23
C	2.2 – 3.7	23 – 32
D	1.4 – 2.2	32 – 48
E	0.7 – 1.4	48 – 74
F	< 0.7	Variable

Source: Highway Capacity Manual (HCM) 2010

LOS criteria for Staircase

LOS	Average Space (m²/p)	Flow Rate (p/min/m)
A	> 1.9	< 16
B	1.6 – 1.9	16 – 20
C	1.1 – 1.6	20 – 26
D	0.8 – 1.1	26 – 36
E	0.5 – 0.8	36 – 48
F	< 0.5	Variable

Source: Highway Capacity Manual (HCM) 2010

- **According to Indian Railway Manual, LOS C shall be maintained, whereas in seasonal peak LOS D is tolerable.**

LITERATURE REVIEW

OVERVIEW OF RAILWAY STATIONS OF UNITED KINGDOM AND INDIA

Overview of selected Railway Stations of United Kingdom

	London King's Cross Railway Station	London Waterloo station	London Victoria Station
Opened in	1852	July 1848	1 October 1860
Station Area (Ha.)	4.2	3.0	3.0
Footfalls/yr. (2014)	91.98 million	91.49 million	86.73 million
Avg. Daily Footfalls	2,52,000	2,50,000	2,38,000
Pax. Handled /Ha./day	**60,000**	**83,000**	**80,000**
No. of Platforms	12 platforms	22 platforms	19 platforms

European Railway Stations are handling **74,000 passengers/Ha/day**

Source: Network Rail (European Rail Operators)

Overview of selected Railway Stations of India

Features	New Delhi	Mumbai Central	Chennai Central	Howrah
Station Category	A1	A1	A1	A1
Station Area (Ha.)	24.5	5.5	8.6	22.0
No. of Passengers dealt with (2014)				
(a) Per Day	4,00,000	17,272	1,15,601	7,36,890
(b) Max. at any time	24,916	2,500	17,340	26,860
Passengers handled /Ha./day	**16,000**	**3,000**	**13,000**	**34,000**
Booking Windows	42	7	11	82
No. of Platforms	16	5	13	23
FOB	3	1	0	1
Subway	0	0	0	2

Indian Railway Stations are handling **16,500 passengers/Ha/day**

Source: Indian Railways

- INTRODUCTION
- METHODOLOGY
- LITERATURE REVIEW
- **DATA BASE**
- STUDY AREA
- NEW DELHI RAILWAY STATION CHARACTERISTICS
- LEVEL OF SERVICE ASSESSMENT
- ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT
- SUMMING UP

DATA BASE

PRIMARY DATA

1. Station Facility Audit Survey

Objective : To cross-check the availability of **passenger's amenities** in the railway station as per the standards of Indian Railway Manual.

2. Station User Opinion Survey – 250 Samples

Objective : To comprehend the **user's outlook (satisfaction level) on the activities / components** of the railway station for further detailed surveys and analysis.

3. Station User Characteristics Survey – 250 Samples

Objective : To analyse **user's characteristics:**

- Dwell Time of each movement and activity
- Profession,
- Income level,
- Time spent on the platforms or waiting lounge, and
- Luggage carried.

DATA BASE

PRIMARY DATA

4. Passengers Count Survey by Videography and Photography Approach

Survey done at Entries / Exits, Platforms, FOB, Staircase and Escalator.

Objectives : 1. To estimate current **daily footfalls**.

2. To analyze **Level of Service (LOS)** for pedestrian space, speed and flow at Platforms, Foot-over-Bridge (FOBs), Staircase and escalator.

Entry/Exit

CCTV footage collection details:-

- No. of Locations : 20
- Duration of videos : 40 hours in total

(At each location: 2 hrs. – 1 morning peak & 1 evening peak hr.)

- Morning Peak hour : 9 am – 10 am
- Evening Peak hour : 5 pm – 6 pm

(Peak hours considered from train running schedule)

Platform – empty track

Staircase & Platform

Paharganj side FoB

Ajmeri Gate side FoB

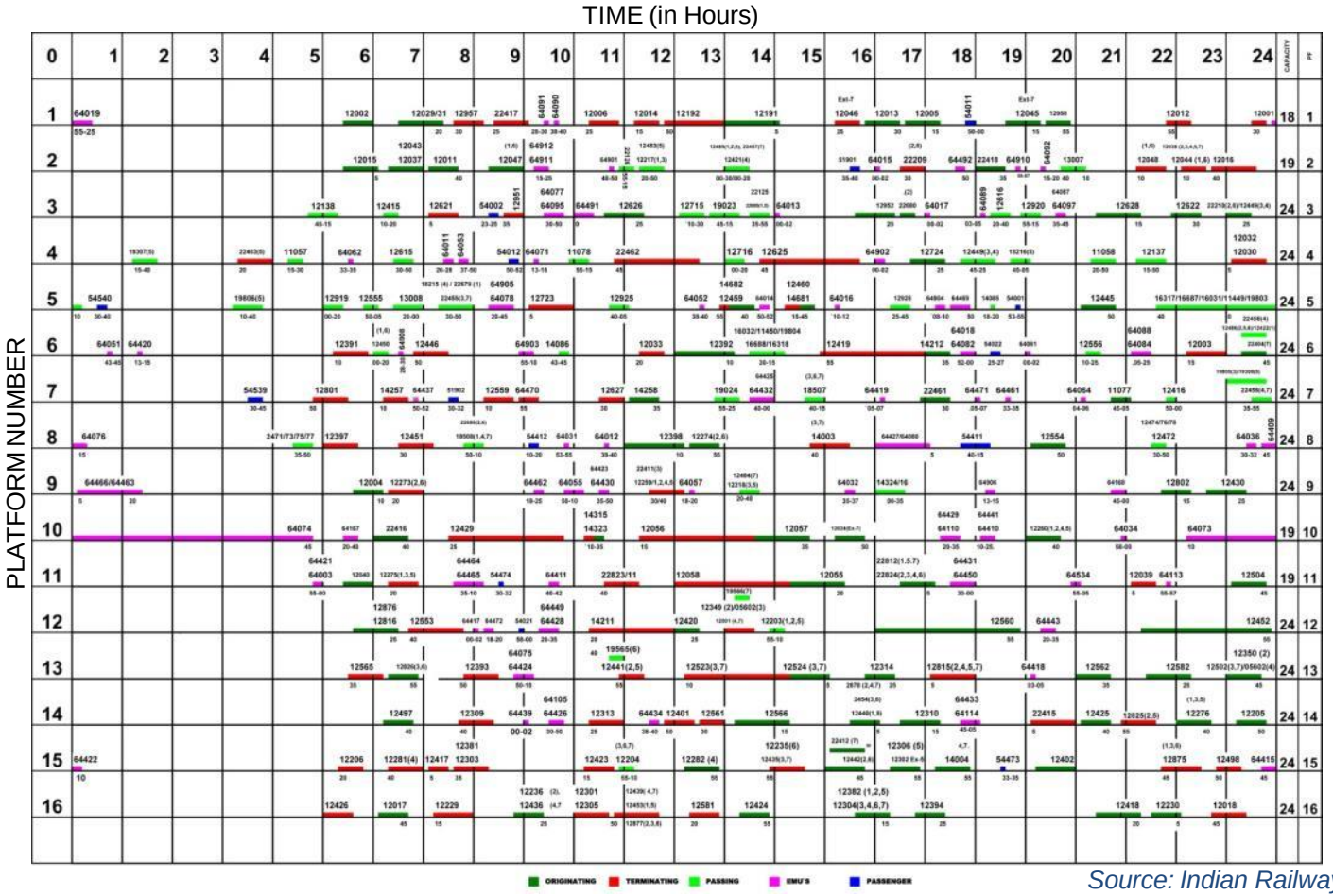
Platform with train

DATA BASE

SECONDARY DATA

1. New Delhi Railway Station **Redevelopment Report 2008** by Terry Farrell & Partners; Ove Arup & Partners and SMEC International Pty Ltd.

2. Presently operational "**Platform Berthing Chart**" of New Delhi Railway Station as shown below:



Source: Indian Railways (Northern), 2016

- INTRODUCTION
- METHODOLOGY
- LITERATURE REVIEW
- DATA BASE
- **STUDY AREA**
- NEW DELHI RAILWAY STATION CHARACTERISTICS
- LEVEL OF SERVICE ASSESSMENT
- ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT
- SUMMING UP

STUDY AREA

DELHI

- National Capital Territory (NCT) of Delhi, is the **capital territory** of India.
- It is bordered by **Haryana on three sides** and by **Uttar Pradesh to the east**.
- **Area** : about **1,484 Km²** (573 sq mi).
- **Population** : about **16.3 million**

Transport Sector in Delhi

ROAD – Delhi has the highest road density of 2103 km/100 Km² in India.

RAIL – In the NCT of Delhi both **inter-city** & **intra-city passenger** movements are being catered to by the existing rail network comprising the **Regional** & **Ring Rail Systems** respectively.

Railway Development in Delhi

- Delhi division falls under **Northern Railways**.
- Approximate track kilometer- **2,875 km**.
- Division runs **582** Mail/Express & Passenger trains.
- Delhi has network of **35 stations**.

Delhi City Map with Railway Tracks

1864 — Delhi Junction (also Old Delhi Railway Station) came into existence

1931 — New Delhi Railway Station became operational

1978 — Hazrat Nizamuddin Railway Station became operational

2009 — Anand Vihar Railway Terminal was redeveloped as a Directional Terminal

STUDY AREA

RAILWAY STATIONS IN DELHI

S. No.	Station Name	No. of Trains per Day	Avg No. of Daily Footfalls (Approx.)	Avg no. of pax./train
1	**New Delhi**	**275**	**5,00,000**	**1818**
2	Old Delhi	232	3,00,000	1293
3	Hazrat Nizamuddin	209	2,00,000	957
4	Anand Vihar Terminus	80	60,000	750
5	Narela	56	20,000	357
6	Delhi Shahdara	75	19,218	256
7	Okhla	70	18,000	257
8	Nangloi	28	10,900	389
9	Tughlakabad	70	10,364	148
10	Palam	30	9,,500	317
11	Delhi Sarai Rohilla	40	8,500	213
12	Delhi Cantonment	32	7,500	234
13	Shakurbasti	35	5,664	162
14	Delhi Kishanganj	35	4,820	138
15	Tilak Bridge	23	3,993	174
16	Shivaji Bridge	21	3,790	180
17	Bijwasan	30	3,500	117
18	Mangolpuri	28	3,400	121
19	Vivek Vihar	60	3,136	52
20	Dayabasti	32	2,437	76
21	Patel Nagar	35	2,410	69
22	Shahbad Mohammadpur	28	2,400	86
23	Adarsh Nagar	56	1,608	29
24	Subzi Mandi	56	1,600	29

Other minor station having footfalls less than 1000 pax./per day

25. Sewa nagar
26. Lajpat nagar
27. Sarojini Nagar
28. Delhi Safdarjung
29. Brar Square
30. Kirti Nagar
31. Lodhi Colony
32. Naraina Vihar
33. Sardar Patel Marg
34. Chanakyapuri
35. Pragati maidan

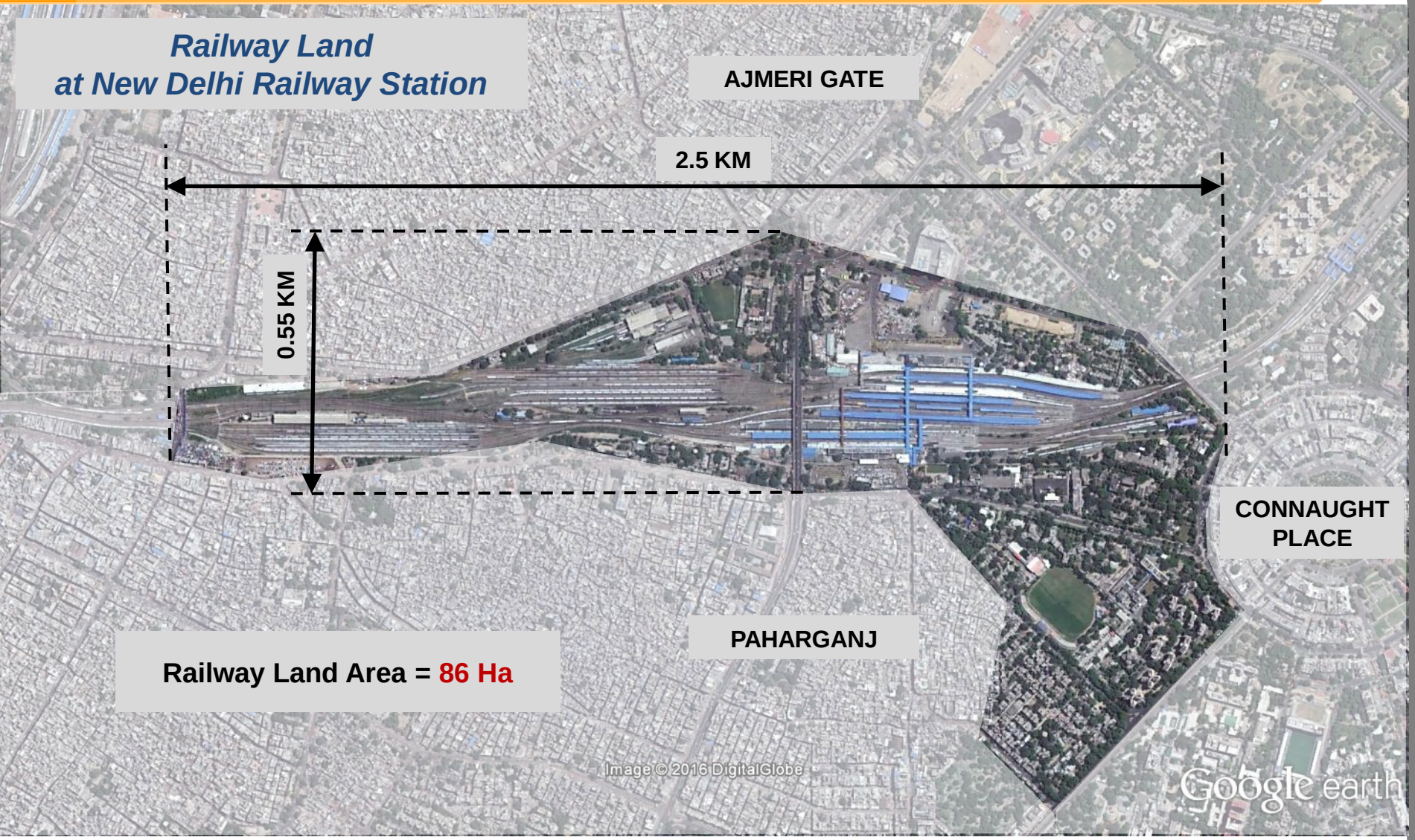
New Delhi Railway Station (NDLS) serves highest number of passengers & train operations per day.

Source: Indian Railways (Northern), 2016

- INTRODUCTION
- METHODOLOGY
- LITERATURE REVIEW
- DATA BASE
- STUDY AREA
- **NEW DELHI RAILWAY STATION CHARACTERISTICS**
- LEVEL OF SERVICE ASSESSMENT
- ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT
- SUMMING UP

PHYSICAL CHARACTERISTICS - NDLS

PHYSICAL PROFILE



Source: Google Earth Map, 2016

PHYSICAL CHARACTERISTICS - NDLS

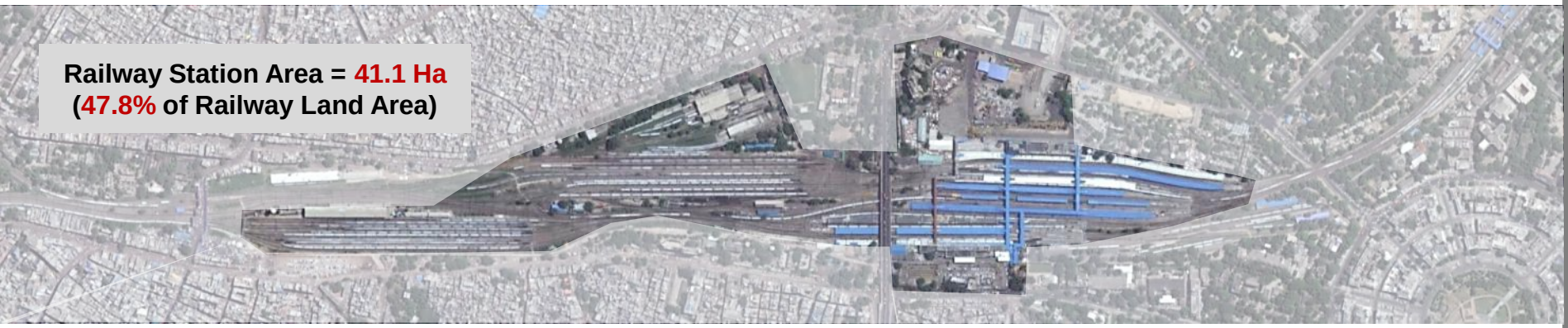
PHYSICAL PROFILE

- The Railway Land Area of **86 Ha**.
- Railway Station Area of **41.1 Ha** which is **48%** of total Railway Land.
- Railway Station Area except Yard Area is **24.5 Ha** (**28%** of Railway Land) that means Yards covers **20%** Railway Land.
- **Two entry / exits** points i.e. Paharganj side (Gate no. 1) and Ajmeri Gate side (Gate no. 2).

Physical Profile Characteristics

Type of Station	Regular
No. of Platforms	16
Railway Land Area	86 Ha.
Railway Station Area	41.1 ha.
Yard Area	16.6 Ha.
Station Building Area	10,000 m²
Building Height	G + 3 max.

Railway Station Area at New Delhi Railway Station



Source: Google Earth Map, 2016

PHYSICAL CHARACTERISTICS - NDLS

PHYSICAL PROFILE

Station Area Details (Excluding Yard Area)

S. No.	Railway Station Area	Area (m^2)	Area (Ha)	%age	Area Type	%age
1	Station Building	10,000	1	4.08	Core and Transit Area	4.08
2	Commercial (Hotels / Yatri Niwas)	16,500	1.65	6.73	Transit Area	6.73
3	Parcel/Cargo Handling Area	20,000	2	8.16	Peripheral Area	8.16
4	**Platforms & Tracks**	**1,30,000**	**13**	**53.06**	**Track-Side Peripheral Area**	**53.06**
6	Circulation	46,200	4.62	18.86	City-Side Peripheral Area	27.96
7	Parking	14,800	1.48	6.04		
8	Metro Station	3,000	0.3	1.22		
9	Others	4,500	0.45	1.84		
	TOTAL	**2,45,000**	**24.5**	**100%**		**100%**

Source: Calculated with the help of Google Earth Maps, 2016

PHYSICAL CHARACTERISTICS - NDLS

DEVELOPMENT NORMS FOR RAILWAY STATIONS IN DELHI

*Railway Station Development Norms as per **Delhi Master Plan 2021***

S. No	Use Premises	Activities Permitted	Area Under Operation	Area Under Building	FAR
1	Rail Terminal / Integrated Passenger Terminal Metropolitan Passenger Terminal	All Facilities related to Railway, Passengers, Operations, Goods Handling, Passengers Change Over Facilities, Including Watch & Ward, Hotel.	70 %	30 %	1.0
2	Rail Circulation	All Facilities related to Railway Tracks, Operational Areas Including Watch & Ward.	--- NA ---		

Present Conditions:

Total Area of Plot : 24.5 Ha.

Area under Operation : 13 Ha (**53 %**)

Area under buildings : 1.6 Ha (**6.5 %**)

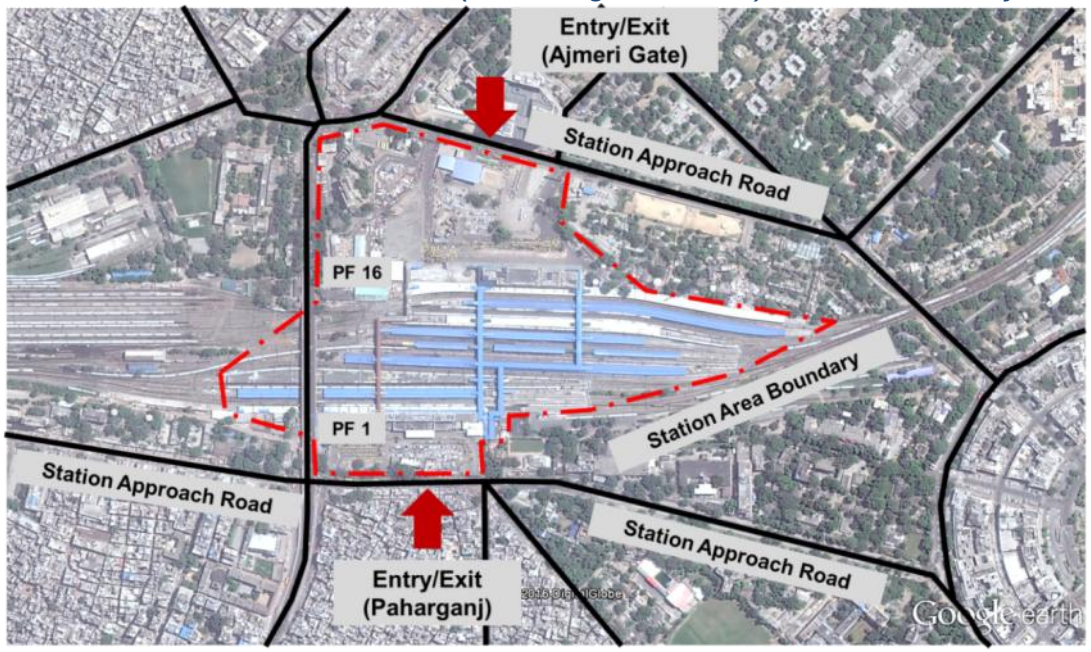
Area Covered on all Floors: 48,500 m²

FAR Allowed : 1.0

Consumed : **0.2**

- **Under utilization of FAR** (Floor Area Ratio)
- Scope of station's infrastructure (facilities or buildings) Future Expansion exists.

New Delhi Station Land (Excluding Yard Area) With Connectivity



Source: Google Earth Map, 2016

PHYSICAL CHARACTERISTICS - NDLS

STATION AUDIT ANALYSIS

Station Facility Audit

S. No.	Amenities	New Delhi (A1)	
		Norms	Existing
1	Booking Facility	√	√
2	Drinking Water Piped / Hand Pump	√	√
3	Waiting Hall	√	√
4	Seating arrangement	√	√
5	Platform shelter / Shady trees	√	√
6	Urinals	√	√
7	Latrines	√	√
8	Platforms: High Level	√	√
9	Lighting	√	√
10	Fans	√	√
11	Foot over bridge (FOB)	√	√
12	Time Table Display	√	√
13	Clock	√	√
14	Water Cooler	√	√
15	Public Address System / Computer based announcement	√	√
16	Parking-cum-circulatory area, with lights	√	√
17	Electronic Train indicator board	√	√
18	Public phone booth	√	√
19	Signage (standardised)	√	√

- **All Minimum Essential Passenger Amenities according to Indian Railway's Norms & Standards are present in the Station Premises.**

Source: Primary Survey, 2016

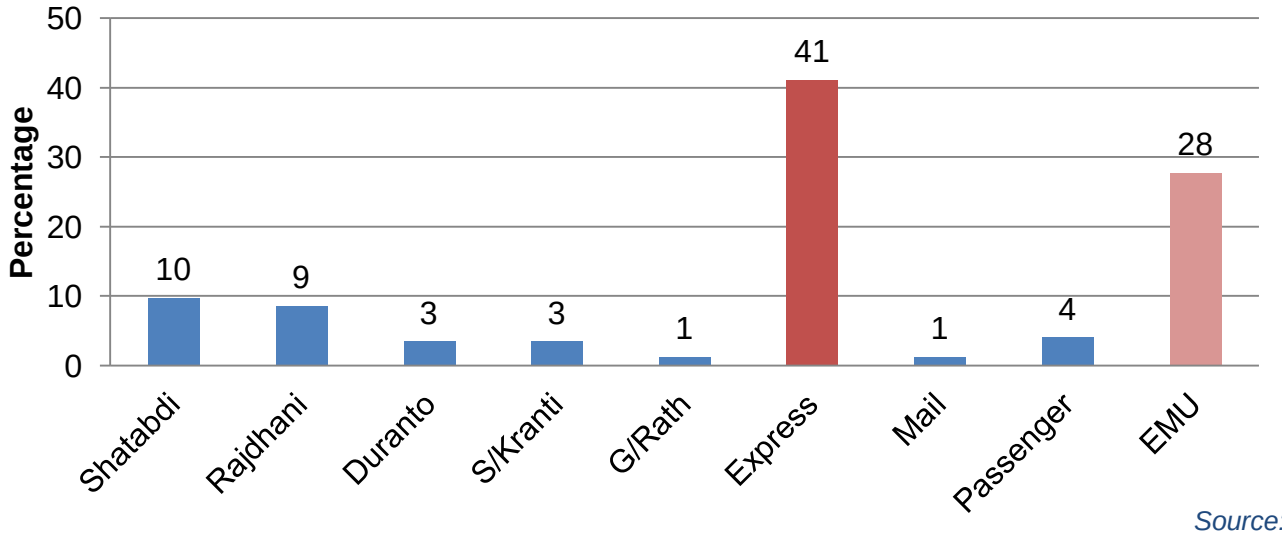
OPERATIONAL CHARACTERISTICS - NDLS

TRAINS MOVEMENT

Trains Movement Pattern at New Delhi Railway Station:

Trains (Frequency)	Originating (total/daily)	Terminating (total/daily)	Passing (total/daily)	Total (total/daily)
Mail/Express	82/63	82/63	76/38	240/164
EMU	24	24	49	97/97
Passenger	00	00	14	14/14
Total	**106/87**	**106/87**	**139/103**	**351/275**

Percentage Share of Train Types (Total)

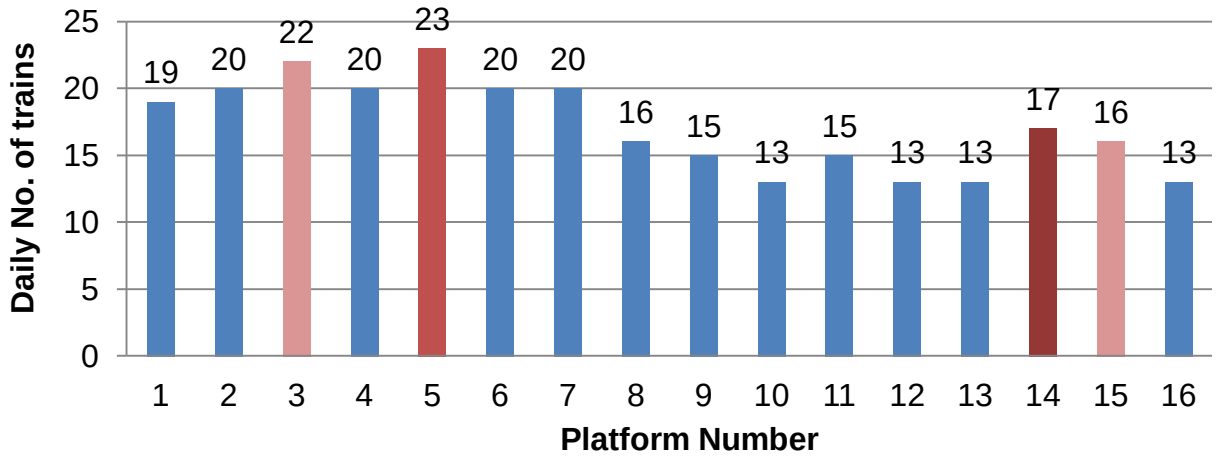


Source: Primary Survey, 2016

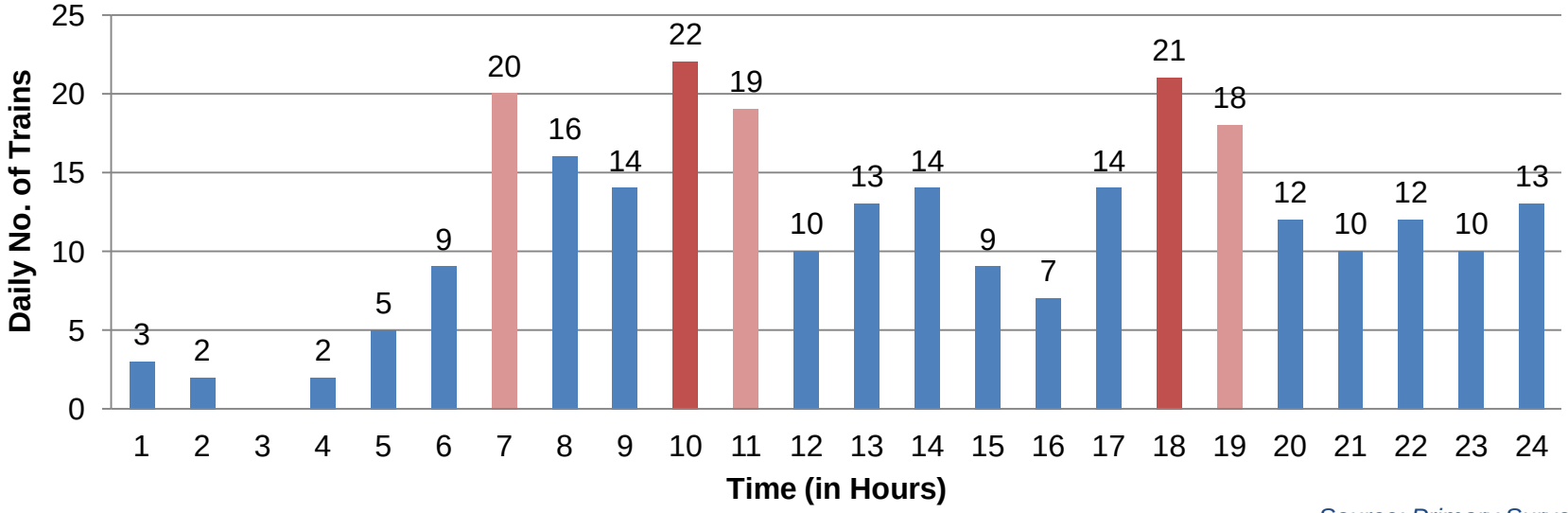
OPERATIONAL CHARACTERISTICS - NDLS

TRAINS MOVEMENT

Platform-wise Train Operations (Daily Average)



Hourly Train Operation Distribution (Daily Average)

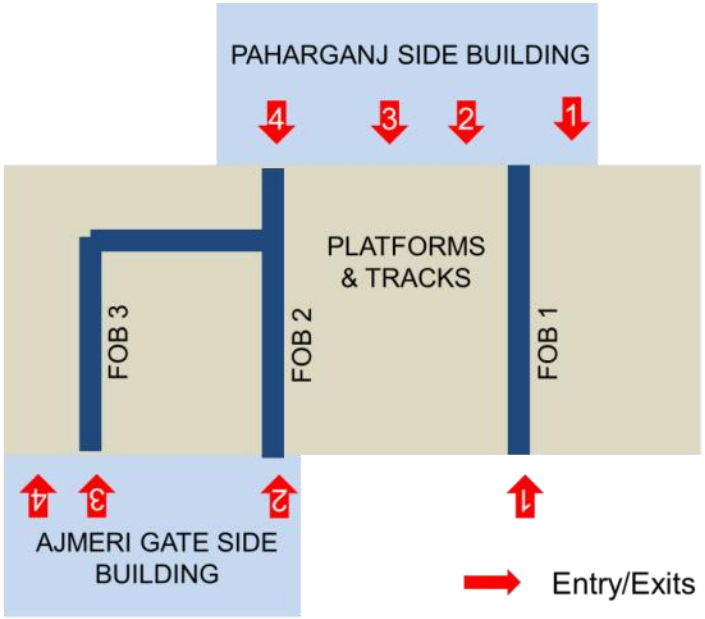


Source: Primary Survey, 2016

OPERATIONAL CHARACTERISTICS - NDLS

DAILY FOOTFALLS ESTIMATION

- Using **videography method**
- **Head-counts** at all 8 Entry/Exit Points
- Location: 4 ponts at Paharganj & 4 points at Ajmeri Gate side in peak hours
- Peak Hours : **9 am** to **10 am** (Morning)
  : **5 pm** to **6 pm** (Evening)



NDLS Conceptual Block Diagram with Survey Locations

STATION USERS PEAK HOUR VOLUME
(Morning & Evening Average Peak Hour Head Counts)

Paharganj Side (Passengers Count)			Total
ENTRY/EXIT NO.	**ENTRY**	**EXIT**	
1	1899	1078	2977
2	1204	1399	2603
3	1379	1542	2921
4	2163	3550	5713
Total	**6645**	**7569**	**14214**
% Share	**47%**	**53%**	
Ajmeri Gate Side (Passengers Count)			**Total**
ENTRY/EXIT NO.	**ENTRY**	**EXIT**	
1	14	2815	2829
2	7337	4536	11873
3	3129	1751	4880
4	1276	896	2172
Total	**11756**	**9998**	**21754**
% Share	**54%**	**46%**	

Total Peak Hour Footfalls: 35968 passengers approx.

Source: Primary Survey, 2016

OPERATIONAL CHARACTERISTICS - NDLS

DAILY FOOTFALLS ESTIMATION

STATION USERS VOLUME PER DAY

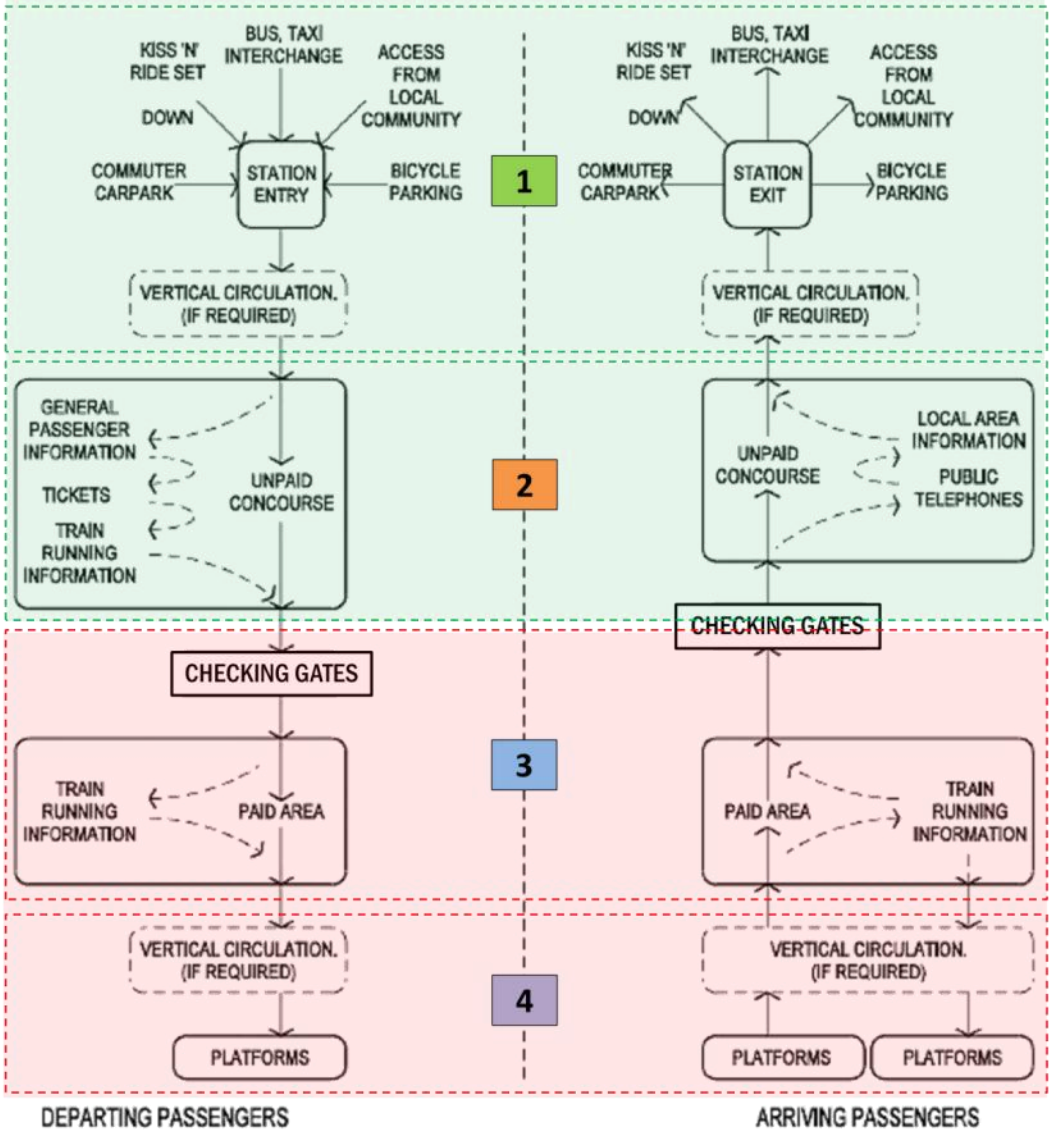
Both Directions (24 Hours Footfalls by taking 7.45% as Peak Hour Factor)				
DIRECTIONS	**ENTRY**	**EXIT**	**TOTAL**	**Directional Distribution**
Paharganj	89,200	1,01,600	1,90,800	**40 %**
Ajmeri Gate	1,57,800	1,34,200	2,92,000	**60 %**
	2,47,000	**2,35,800**	**4,82,800**	**100 %**

- Peak Hour Factor has been taken as **7.45 % of 24 hours footfalls**
  (taken from previous report prepared by consultants in year 2008)
- **4,82,800 approx. daily footfalls** in the Station premises.
- **60 % passenger** footfalls at **Ajmeri Gate** side, because of:
  - Availability of PT like **bus service & metro**,
  - **Multilevel car parking** etc.
  - Lower Congestion level as compare to Paharganj.

Source: Primary Survey, 2016

OPERATIONAL CHARACTERISTICS - NDLS

PASSENGER CIRCULATION IN STATION PREMISES



PASSENGER CIRCULATION DIAGRAM

Legend

- Unpaid Area
- Paid Area
- 1 City-Side Peripheral & Transit Area
- 2 Core Area
- 3 Admin Area
- 4 Track-Side Peripheral & Transit Area

Source: Primary Survey, 2016

OPERATIONAL CHARACTERISTICS - NDLS

PASSENGER CIRCULATION IN STATION PREMISES

Source: Primary Survey, 2016


Approach Road


Public Transport Availability


Entrance of Station Premises

Directions Boards at Entrance


Dedicated Lanes for modes with Parking


Entry to Station Building


Provision of Ramps and Escalators

Info Board on building entry


Passengers waiting in building premises

Ticketing Windows and Enquiry

Ticket Vending Machines


Waiting Lounges and Areas

Entry towards FOBs for Platforms


Signage at FOBs


Signage at Platforms


Passengers waiting at Platforms

OPERATIONAL CHARACTERISTICS - NDLS

DWELL TIME

Noting time spent by each person (250 random samples) in each activity or process and taken average for three types of passenger.

Average Dwell Time

Station Component		Unreserved Departing Passenger (in Minutes)	Reserved Departing Passenger (in Minutes)	Arriving Passenger (in Minutes)
City - Side Peripheral Area		6	6	4
Core Area		5	1	0
Administrative & Transit Area		1	1	1
Track - Side Peripheral Area	**Circulation**	4	4	4
	Waiting at Platform	30	25	5
Total		**46**	**37**	**14**

- **65 - 68 % Average Dwell Time** is spent in **Track-side Peripheral Area** i.e. Platforms and their approach (includes vertical movement through Stairs / Elevators / Escalators) by Departing Passengers.
- Followed by **City-side Peripheral area** with **13 – 28 % Average Dwell Time** spent by passengers.

Source: Primary Survey, 2016

OPERATIONAL CHARACTERISTICS - NDLS

PASSENGER (USER) RATINGS FOR EACH ACTIVITY

S. No.	Activity	Area Type	Rating (in %)					Passenger's Comments
			V G	G	A	P	V P	
1	Ticket Purchase and Enquiry	Core	24	18	**38**	14	6	-- Inadequate management
2	Retailing	Transit	32	**40**	22	4	2	
3	Vending (machines)	Core	10	14	12	22	**42**	-- Cannot find TVMs & high % of illiteracy
4	Provision of information to passengers for their rail and / or onward journeys	Core	**56**	14	22	2	6	
5	Passage through any gate-line	Core	10	**40**	36	2	12	
6	Way-finding (signage)	All Areas	8	8	**36**	22	26	-- Symbols / Icons are not drawn
7	Access to and from platforms	Peripheral (Track)	14	12	**32**	20	22	-- Absence of Escalators -- Passengers used to sit on Stairs
8	**Waiting for trains**	**Peripheral (Track) & Transit**	6	14	22	28	**30**	-- Very less of benches and chairs to sit -- No provision for luggage handling
9	**Boarding and alighting from trains**	**Peripheral (Track)**	10	12	26	20	**32**	-- Cross movement of boarding & alighting passengers
10	Accessing other modes of transport	Peripheral (City)	**38**	22	24	6	10	

- **Passengers / Users not satisfied with track-side Peripheral Area**.

Track-Side Peripheral Areas i.e. Platforms & Vertical Circulation are getting **primary concern** from User perspective as well as according to Indian Railway Manual for better Planning & Design for Productivity Improvements.

Rating:- VG – Very Good
G – Good
A – Average
P – Poor
VP – Very Poor

Maximum Ratings

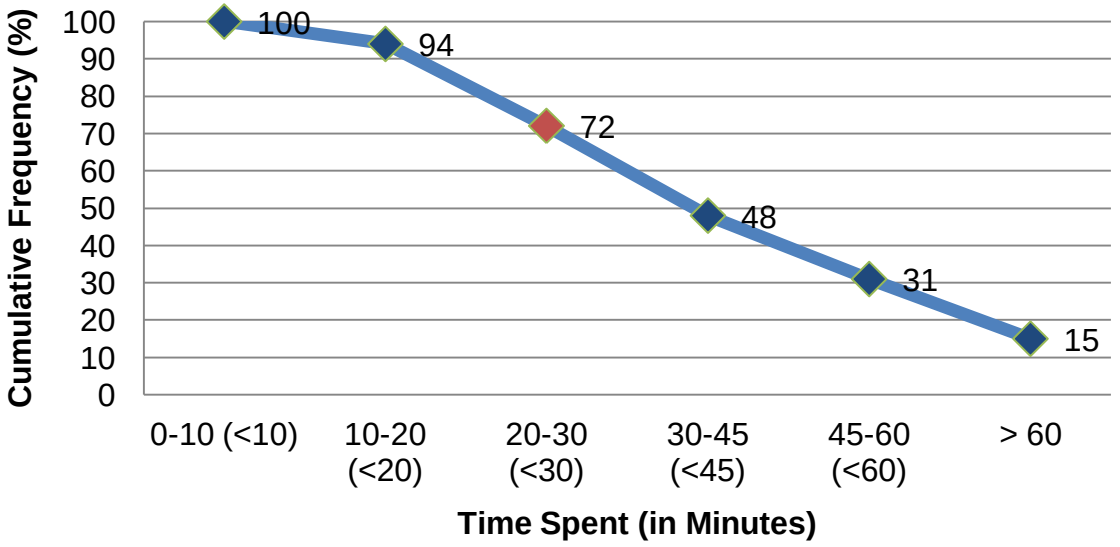
Source: Primary Survey, 2016

PASSENGER CHARACTERISTICS - NDLS

TIME SPENT BY USERS AT PLATFORMS / WAITING AREAS

Distribution of Passengers by Time Spent

Time Spent by Passengers		
Time spent (in min.)	**Percentage**	**Cumulative %age**
0-10 (<10)	6	100
10-20 (<20)	22	94
20-30 (<30)	**24**	**72**
30-45 (<45)	17	48
45-60 (<60)	16	31
> 60	15	15



- Most of the passengers are spending **20-30 min**. at station

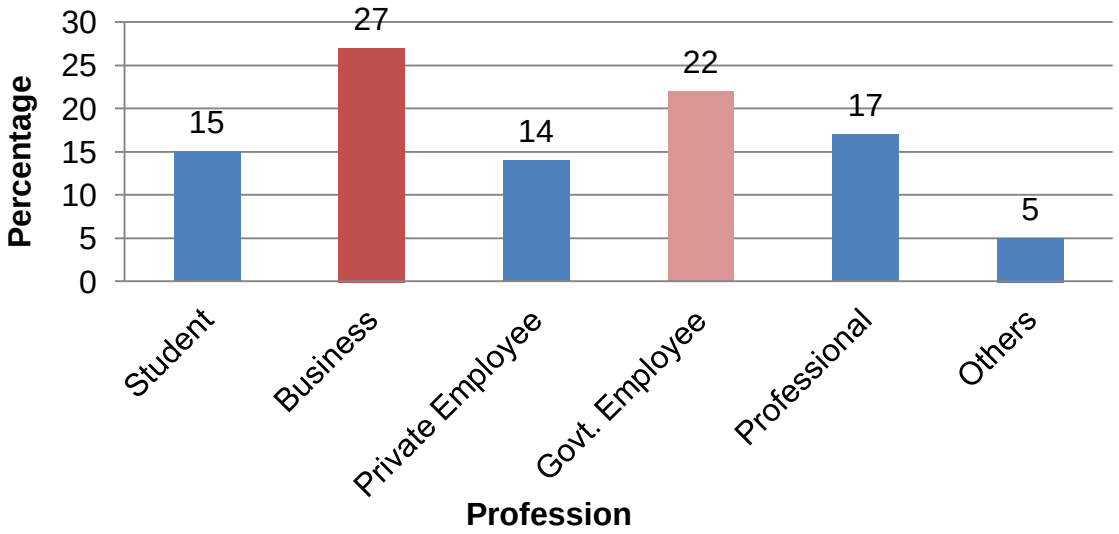
Source: Primary Survey, 2016

PASSENGER CHARACTERISTICS - NDLS

PROFESSION

Distribution of Passengers by Profession

Profession of Passengers	
Profession	**Percentage**
Student	15
Business	**27**
Private Employee	14
Govt. Employee	22
Professional	17
Others	5



- **27 % are Business People** & 22 % Govt. Employees

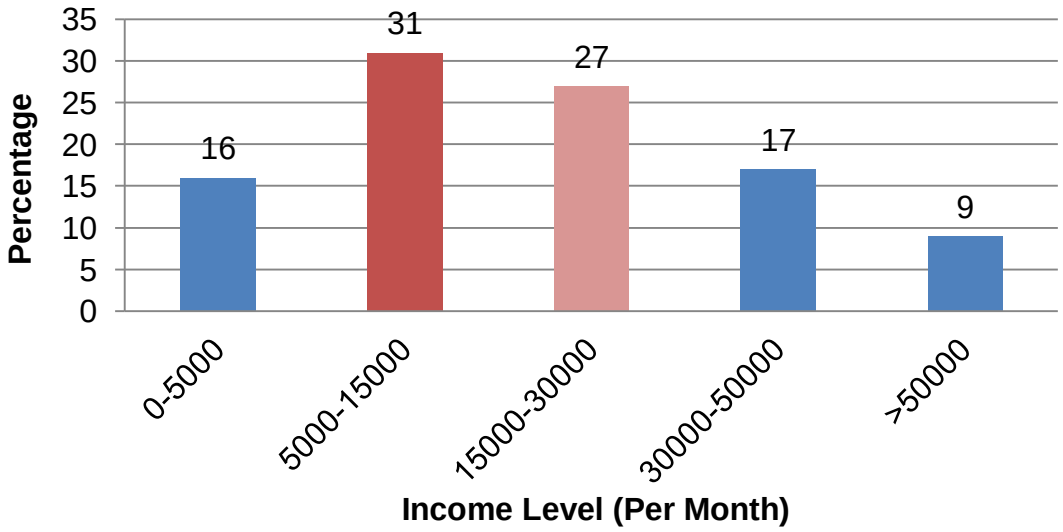
Source: Primary Survey, 2016

PASSENGER CHARACTERISTICS - NDLS

INCOME LEVELS (PER MONTH)

Distribution of Passengers by Monthly Income

Per Month Income Level of Passengers	
Income Group	**Percentage**
0 – 5000	16
5000 – 15000	**31**
15000 – 30000	27
30000 – 50000	17
> 50000	9



- **31 %** of the station users earn between **Rs. 5000 to Rs. 15000**

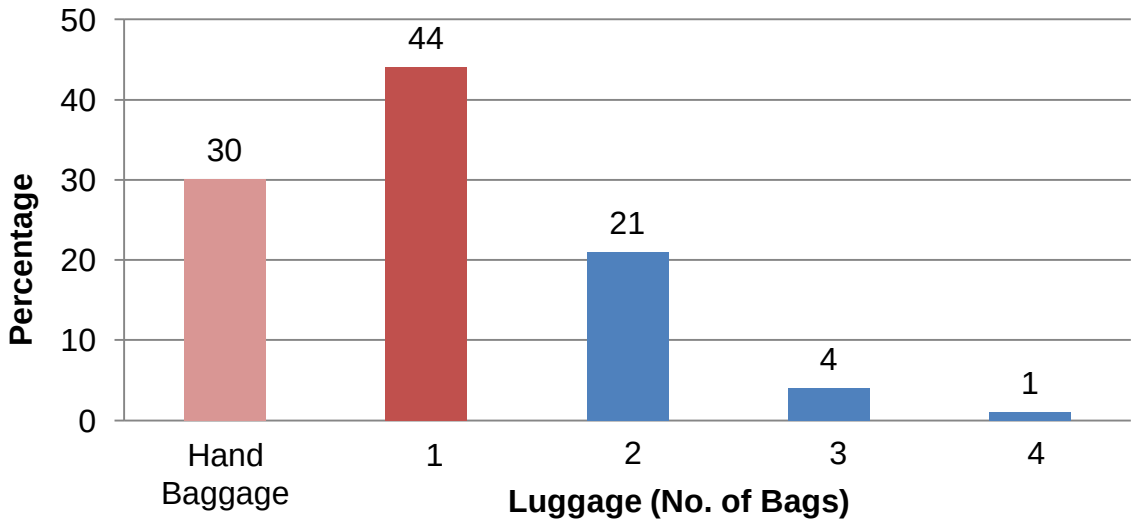
Source: Primary Survey, 2016

PASSENGER CHARACTERISTICS - NDLS

LUGAGGE

Distribution of Passengers by Monthly Income

Luggage Carrying Characteristics	
Luggage	**Percentage**
Hand Baggage	30
1	**44**
2	21
3	4
4	1



- **44 %** passengers are carrying **one bag** as their luggage.

Source: Primary Survey, 2016

PASSENGER CHARACTERISTICS - NDLS

LUGAGGE

- Average number of baggage carried by per passenger = **1.02** (approx. **1 bag / person**) excluding hand bags.
- Observed that “space occupied by one bag is equal to space occupied by one passenger”.
- Baggage impact for LOS calculations – **one passenger has to be consider as occupying space of two person**.

Source: Primary Survey, 2016

- INTRODUCTION
- METHODOLOGY
- LITERATURE REVIEW
- DATA BASE
- STUDY AREA
- NEW DELHI RAILWAY STATION CHARACTERISTICS
- **LEVEL OF SERVICE ASSESSMENT**
- ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT
- SUMMING UP

LEVEL OF SERVICE ASSESSMENT

WALKWAY / FOOT-OVER-BRIDGE (FOB)

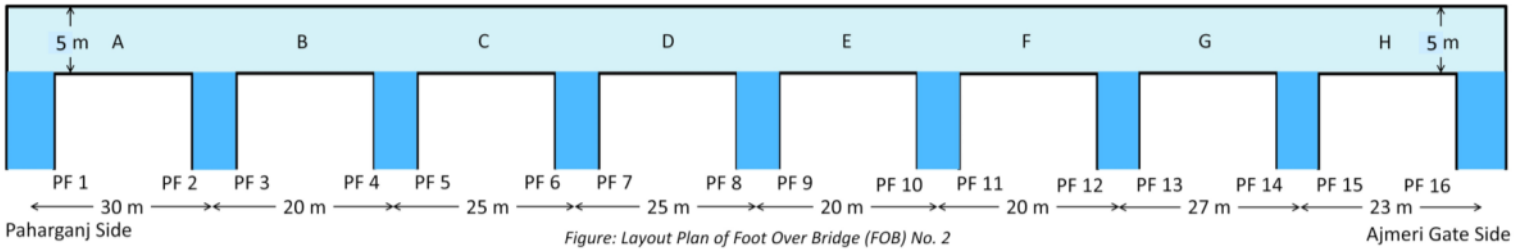
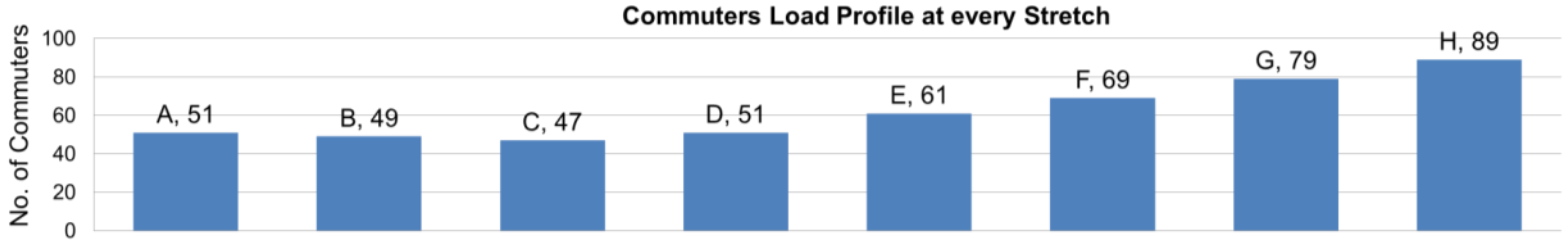


Figure: Layout Plan of Foot Over Bridge (FOB) No. 2



Commuter Behavior at Foot-over-Bridge (FOB)									TOTAL
No. of Commuters	51	49	47	51	61	69	79	89	**140**
FOB Length (m)	30	20	25	25	20	20	27	23	**190**
Commuter Meters	1530	980	1175	1275	1220	1380	2133	2047	**11740**

Average length covered per commuter (on FOB) = 11740 / 140 = **84 m** & Average time spent per commuter (on FOB) = 84 / 42 = **2 min.**

Level of Service (LOS) Assessment for Foot-over-Bridge (FOB)									AVERAGE
Speed (m/min)	48	42	48	48	42	36	36	36	**42**
Flow (p/m/min)*	25	23	21	20	20	21	26	30	**23**
Space (m²/pax)*	1.9	1.8	2.3	2.4	2.1	1.7	1.4	1.2	**2.1**
LOS	D	D	C	C	D	D	D	E	**D**

**Luggage impact has been considered*

Source: Primary Survey, 2016

LEVEL OF SERVICE ASSESSMENT

STAIRWAYS AND ESCALATORS

Level of Service (LOS) Assessment for Stairways and Escalators

Service	Average Width (m)	Average Speed (m/min)	Average Flow Rate (p/min/m)*	Average Space (m^2/p)*	LOS
Staircase	3.5**	30	33	0.9	**D**
Escalators	1	39	30	1.3	**C**

** Luggage impact has been considered*

*** Reduced one meter width (0.5m on each edge) occupied by passengers sitting illegally – for LOS calculations.*

Total Average Width of Staircase = 4.5 m

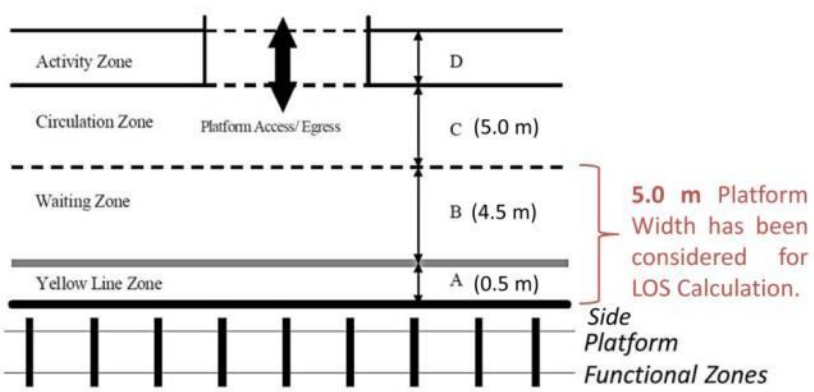
Source: Primary Survey, 2016

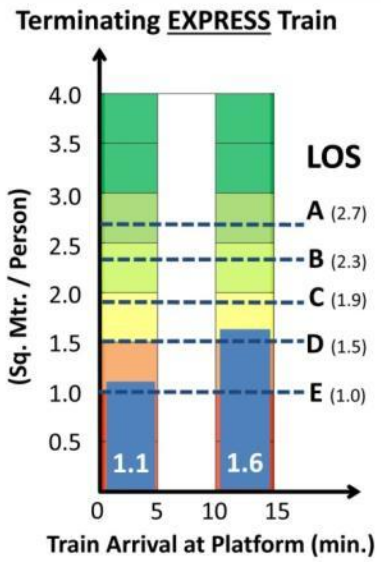
LEVEL OF SERVICE ASSESSMENT

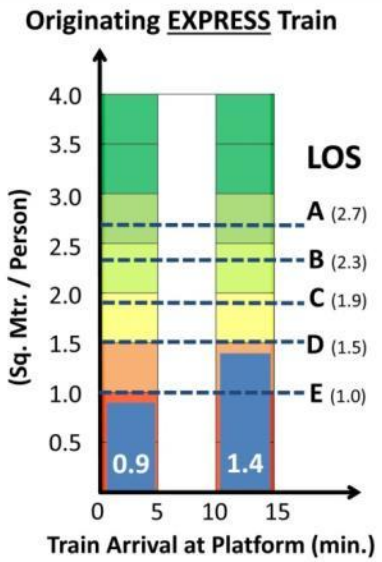
TRAIN-TYPE-WISE LOS ASSESSMENT AT SIDE PLATFORM

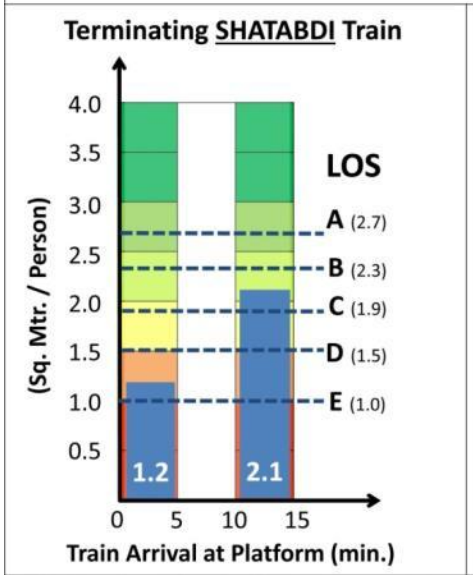
Source: Primary Survey, 2016

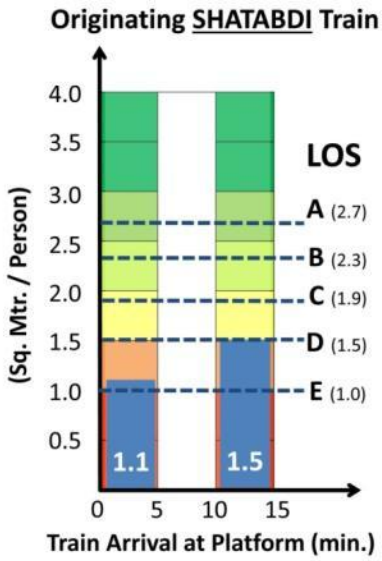
Level of Service (LOS): Waiting at Platforms
Platform No. : 01 (Side Platform)
Train types covered: Shatabdi, Rajdhani & Express
Assumptions: 1 bag per passenger and each bag covering equal space as a passenger

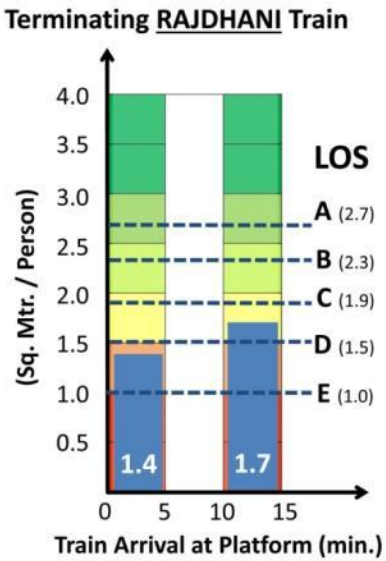


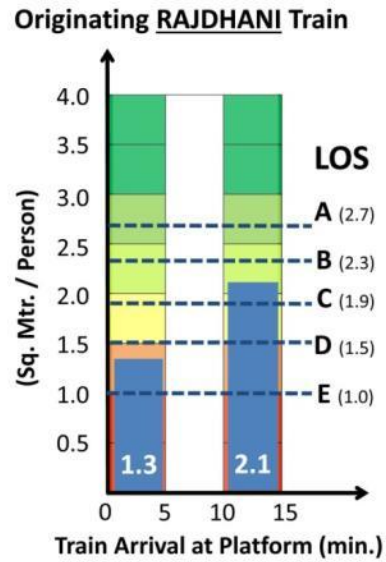










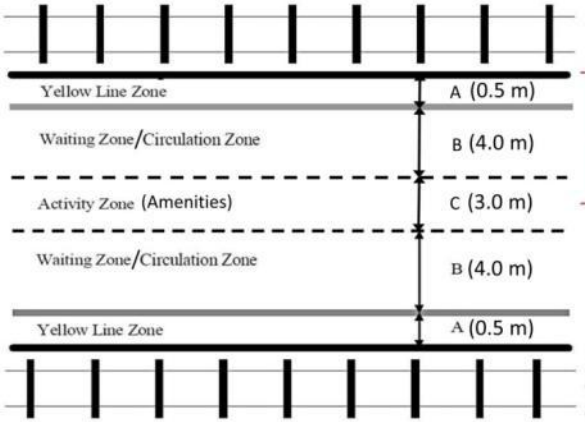


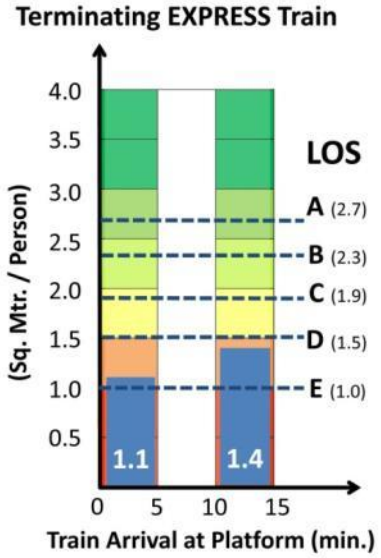
LEVEL OF SERVICE ASSESSMENT

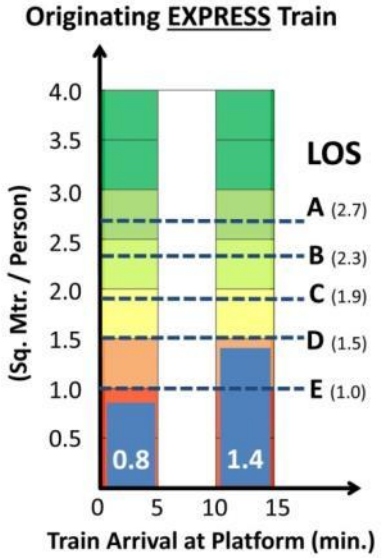
TRAIN-TYPE-WISE LOS ASSESSMENT AT ISLAND PLATFORM

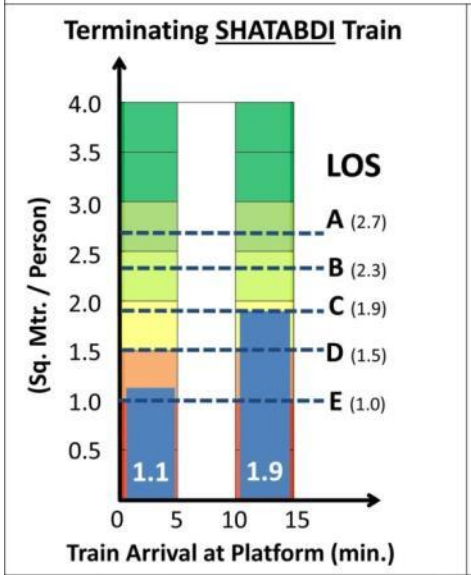
Source: Primary Survey, 2016

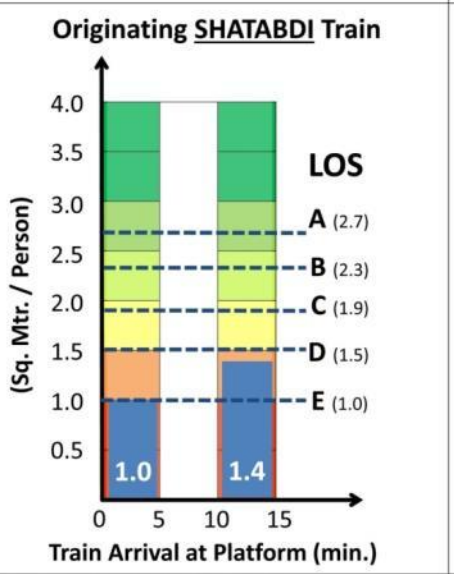
Level of Service (LOS): Waiting at Platforms
Platform No. : 10-11 (Island Platforms)
Train types covered: Shatabdi, Rajdhani & Express
Assumptions: 1 bag per passenger and each bag covering equal space as a passenger

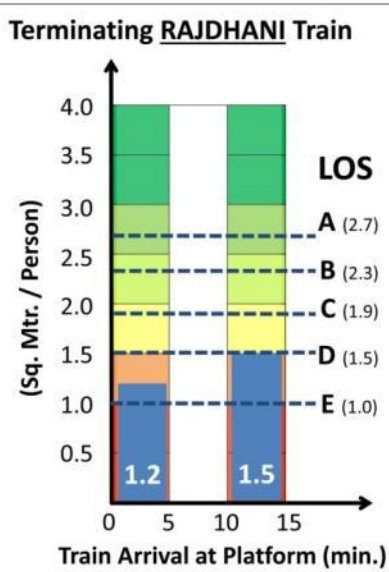


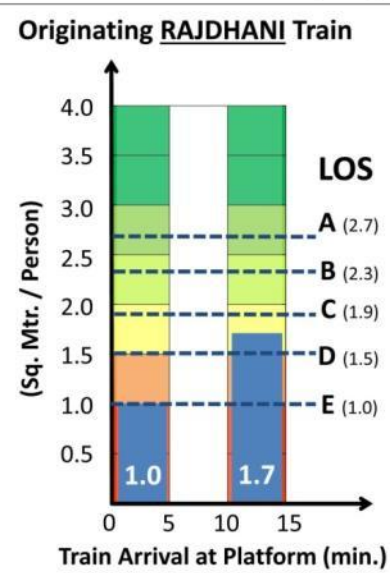










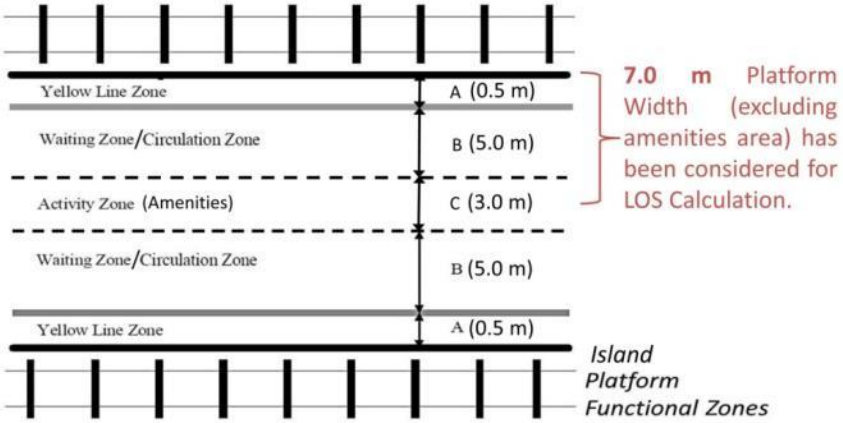


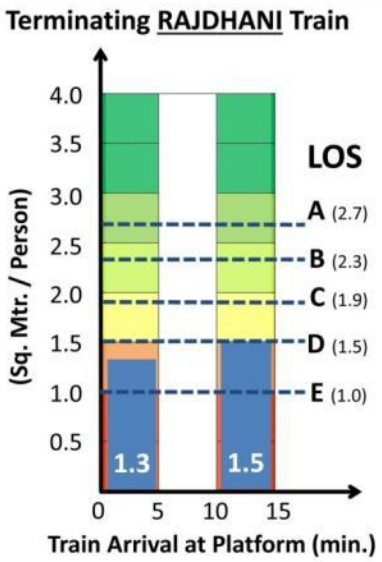
LEVEL OF SERVICE ASSESSMENT

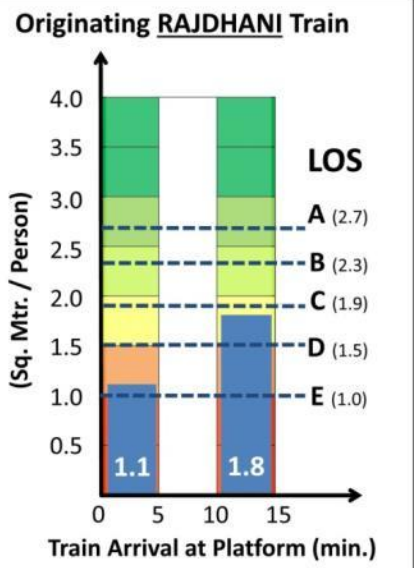
TRAIN-TYPE-WISE LOS ASSESSMENT AT ISLAND PLATFORM

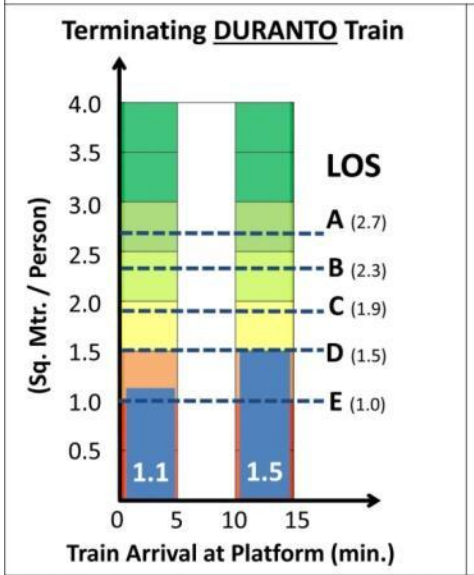
Source: Primary Survey, 2016

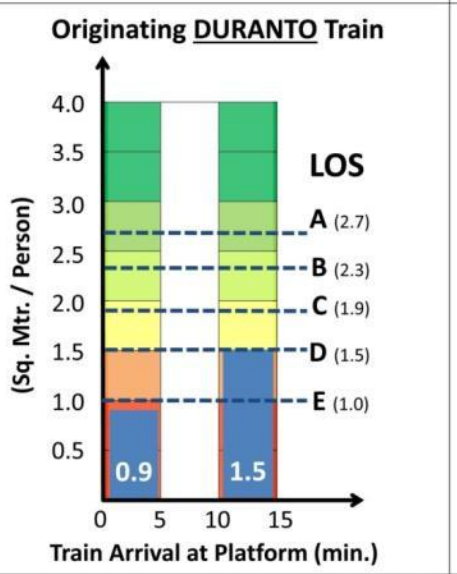
Level of Service (LOS): Waiting at Platforms
Platform No. : 14-15 (Island Platforms)
Train types covered: Rajdhani, Duranto & S/Kranti
Assumptions: 1 bag per passenger and each bag covering equal space as a passenger

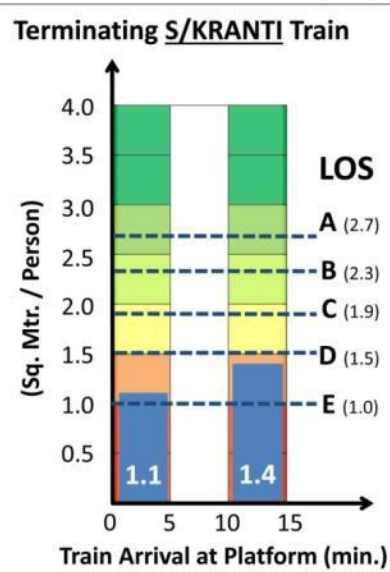


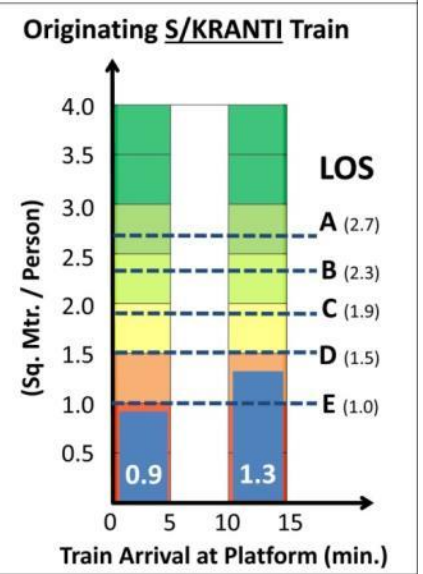








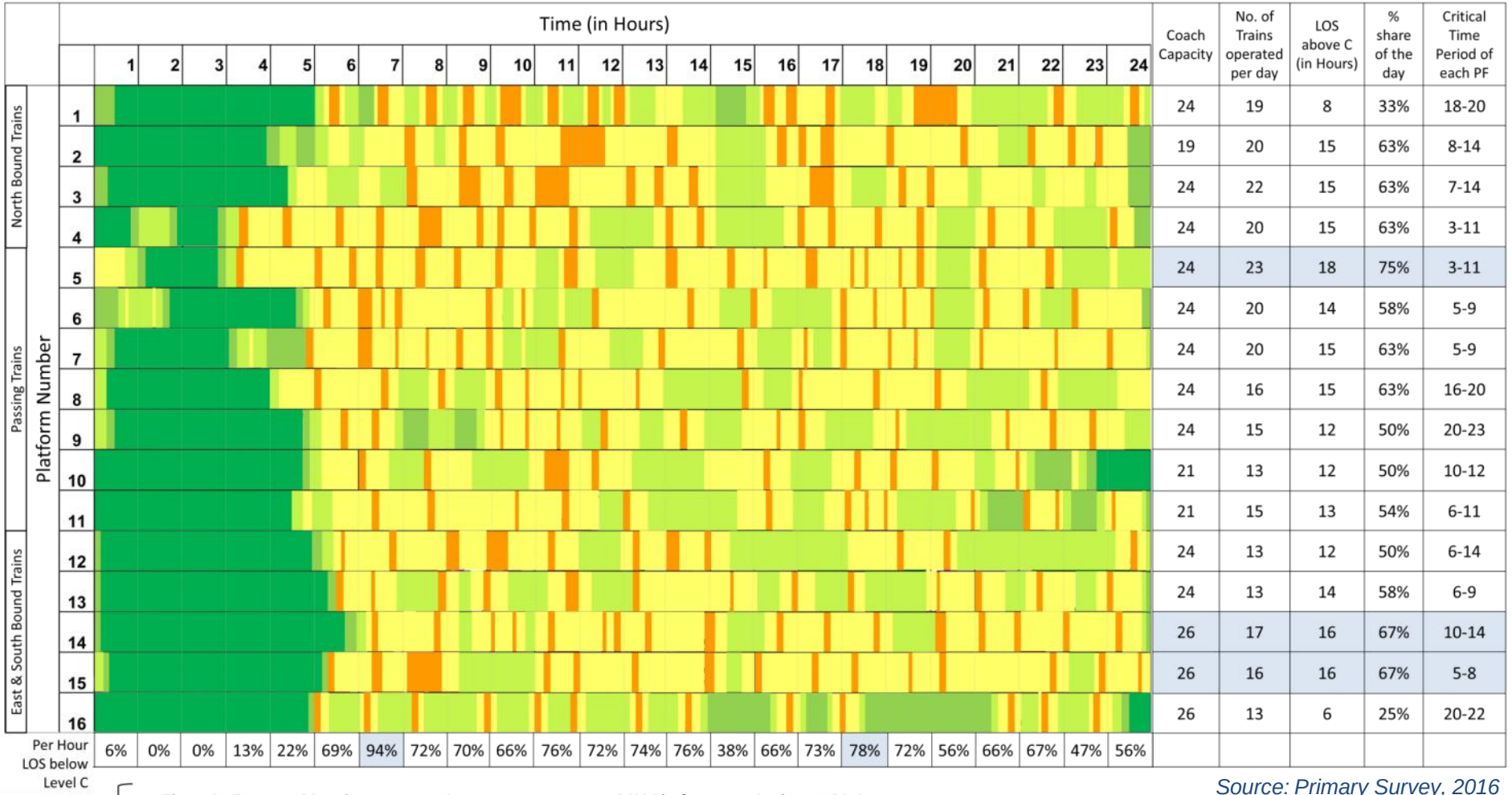




LEVEL OF SERVICE ASSESSMENT

PLATFORM-WISE LOS ASSESSMENT

PATTERN OF LOS BEHAVIOR THROUGHOUT THE DAY (Assumption: One train service type's LOS will remain same at other times of the day and at same platform type)



Platform Number	Coach Capacity	No. of Trains operated per day	LOS above C (in Hours)	% share of the day	Critical Time Period of each PF
1	24	19	8	33%	18-20
2	19	20	15	63%	8-14
3	24	22	15	63%	7-14
4	24	20	15	63%	3-11
5	24	23	18	75%	3-11
6	24	20	14	58%	5-9
7	24	20	15	63%	5-9
8	24	16	15	63%	16-20
9	24	15	12	50%	20-23
10	21	13	12	50%	10-12
11	21	15	13	54%	6-11
12	24	13	12	50%	6-14
13	24	13	14	58%	6-9
14	26	17	16	67%	10-14
15	26	16	16	67%	5-8
16	26	13	6	25%	20-22

FINDINGS

- **Time: 6 - 7am** : **20 trains** are operating. **94%** Platform area is above LOS C.
- **Time: 5 - 6pm** : **21 trains** are operating. **78%** Platform area is above LOS C.
- **PF No. 5** : **23 trains** are operating. **75%** of the day duration Above LOS C.
- **PF No. 14-15** : **17 & 16 trains** are operating respectively. **67%** of the day duration above LOS C.

Source: Primary Survey, 2016

LEGEND

A	B	C	D	E	F	LOS (sq. m. / Person)
2.7	2.3	1.9	1.5	1.0		

- INTRODUCTION
- METHODOLOGY
- LITERATURE REVIEW
- DATA BASE
- STUDY AREA
- NEW DELHI RAILWAY STATION CHARACTERISTICS
- LEVEL OF SERVICE ASSESSMENT
- **ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT**
- SUMMING UP

ALTERNATE STRATEGIES

STRATEGY 1 – STAGGERING OF TRAINS SCHEDULE (Immediate Action)

Limitations:

1. Trains can be staggered only within their own directional platform groups
   - Platform No. 1-4 : North Bound Trains
   - Platform No. 5-11 : Passing Trains
   - Platform No. 12-16 : East & South Bound Trains

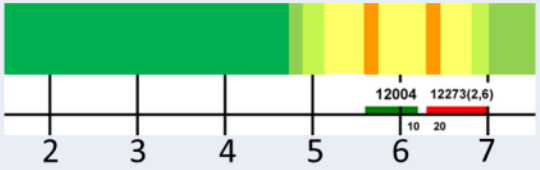
2. Only **Short Distance** (around **700 Km radius**) **trains** can be shifted into the early **morning slot of 1am - 5am**, rest of the trains can be only flipped on other platforms without any change in timings.

Example of Staggering

Case 1: Change in train time, no change in PF No:

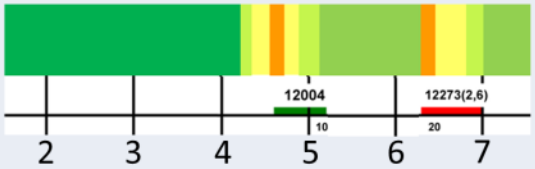
- PF No. 9, Shatabdi Train Departure Time 6:10

Present LOS:



- Staggering train departure time to 5:10

New LOS:

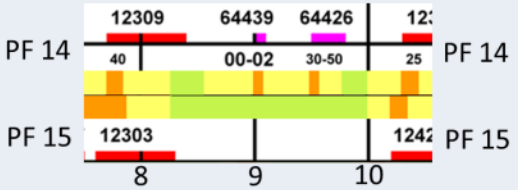


❖ LOS above C reduced by **40 min.**

Case 2: Change in PF No., no change in Train Time:

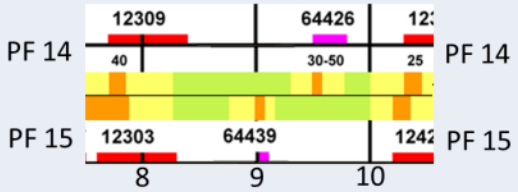
- PF No. 14, EMU Train Time 9:00 – 9:02

Present LOS:



- Staggering train schedule from PF 14 to PF 15

New LOS:



❖ LOS above C gets reduced by **30 min.**

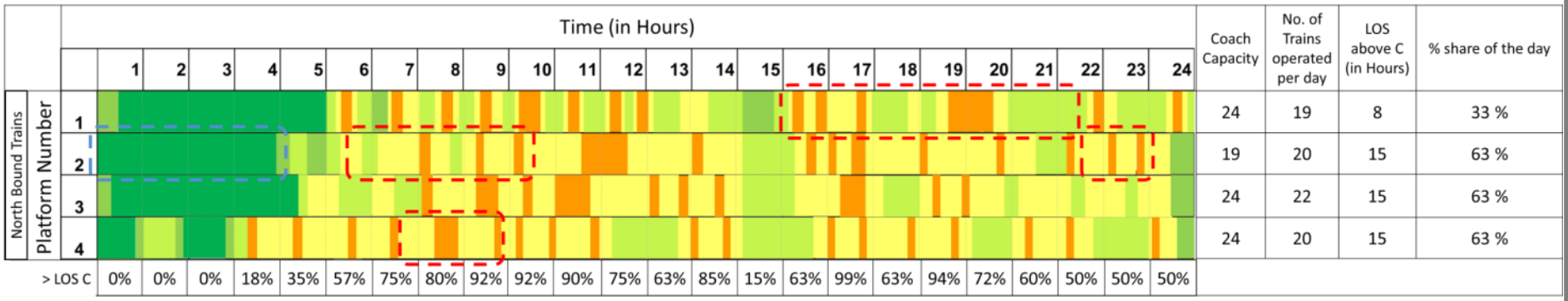
ALTERNATE STRATEGIES

STRATEGY 1 – STAGGERING OF TRAINS SCHEDULE (Immediate Action)

Evaluation Criteria:

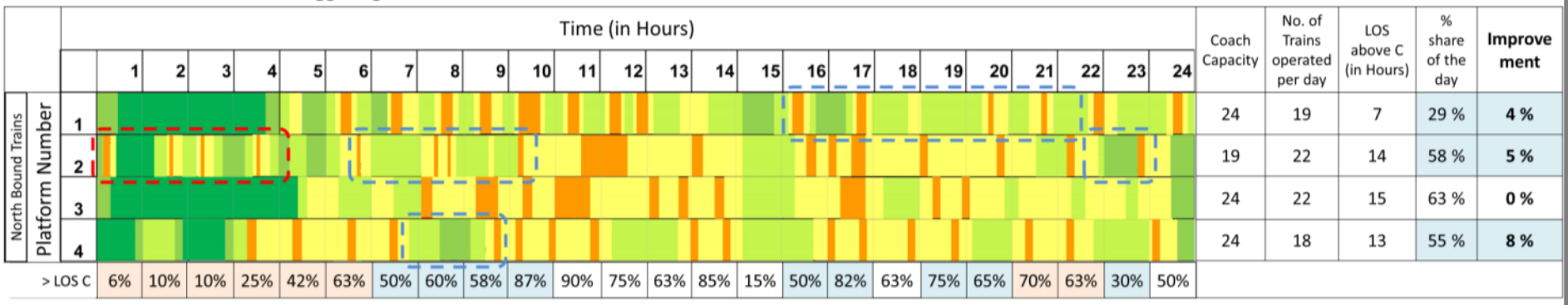
1. Considering only North Bound Trains i.e. Platform Number 1 – 4
2. Shifting 6 Shatabdi Trains into early morning slot of 1am – 5am
3. Flipping scheduled platform to another available Platform for 2 EMU Trains

EXISTING Platform-wise LOS



Coach Capacity	No. of Trains operated per day	LOS above C (in Hours)	% share of the day
24	19	8	33 %
19	20	15	63 %
24	22	15	63 %
24	20	15	63 %

EVALUATION FOR STRATEGY 1: Staggering of Trains Schedule



Coach Capacity	No. of Trains operated per day	LOS above C (in Hours)	% share of the day	Improvement
24	19	7	29 %	4 %
19	22	14	58 %	5 %
24	22	15	63 %	0 %
24	18	13	55 %	8 %

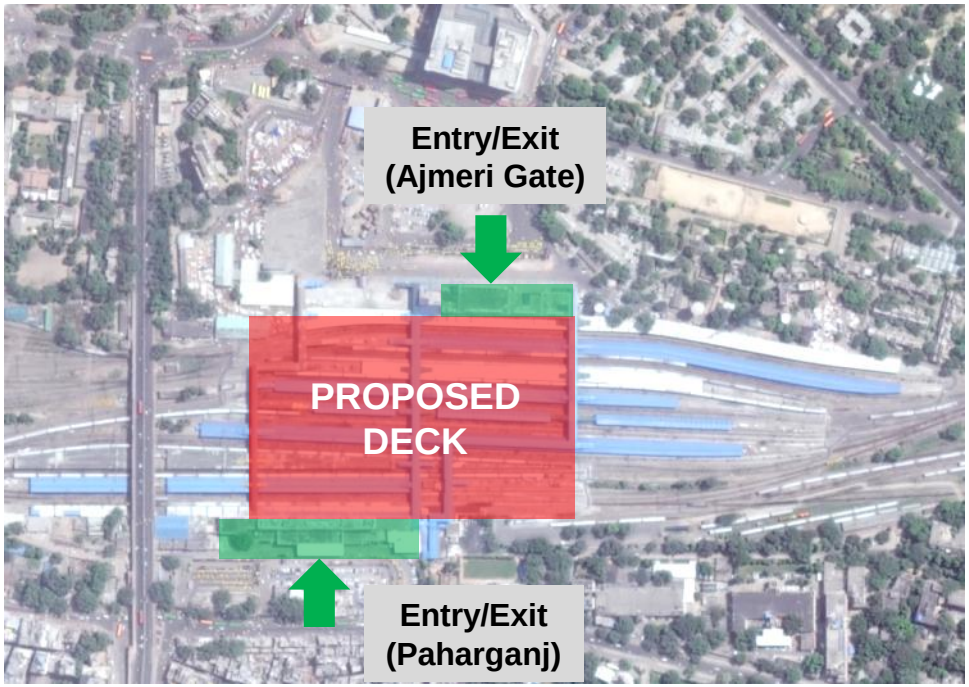
- **4 – 8 % Improvement in overall LOS**

ALTERNATE STRATEGIES

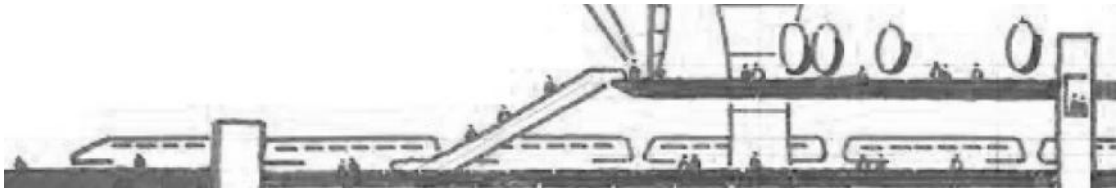
STRATEGY 2 – CROWD MANAGEMENT (Short Term)

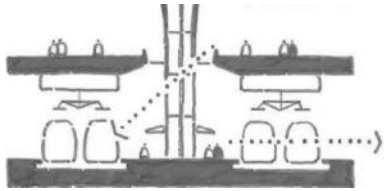
Crowd Management by creating **"Departing Lounge Deck"**

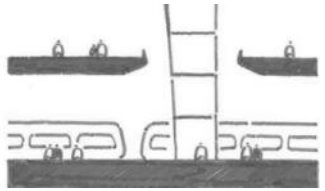
- Deck above Track-side Peripheral Area (Platforms and Tracks), at the level of existing Foot-over-Bridge (FOB).
- Entry/exit at deck level with better facilities for access/dispersal.
- Shifting all platform facilities like Shops, utilities, etc. to Departing Lounge Deck.
- Increased passenger flow by providing escalators & elevators for vertical movements along with stairs.
- Access to Platforms only before 15 minutes of train departure.



Proposed Departing Lounge Deck







ALTERNATE STRATEGIES

STRATEGY 2 – CROWD MANAGEMENT (Short Term)

Calculations:

Total Area of Proposed Deck = 60,000 m²

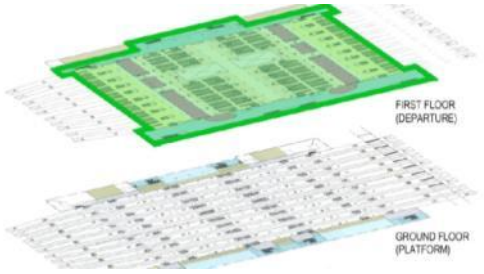
Peak hour average entering volume = 18,400 Passengers.

Considering, 60% of entering volume is using deck at any particular time;

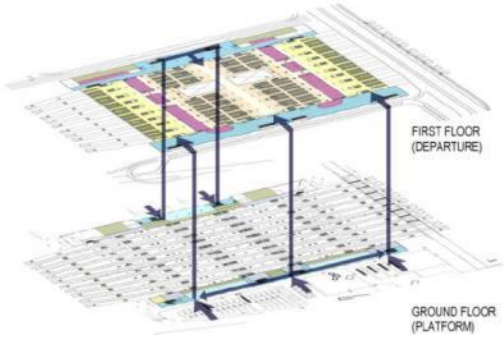
Area available per passenger = 5.45 m²

Norms & standards for Waiting Hall = 5 m² per passenger

{As per Unpublished SPA Thesis (Planning & Design of an Intercity Bus Terminal, Case Study: Sarai Kale Khan, New Delhi) by Hariharan, T.R. (1998)}



Proposed Departing Lounge Deck at First Floor Level (Above Platforms & Tracks)

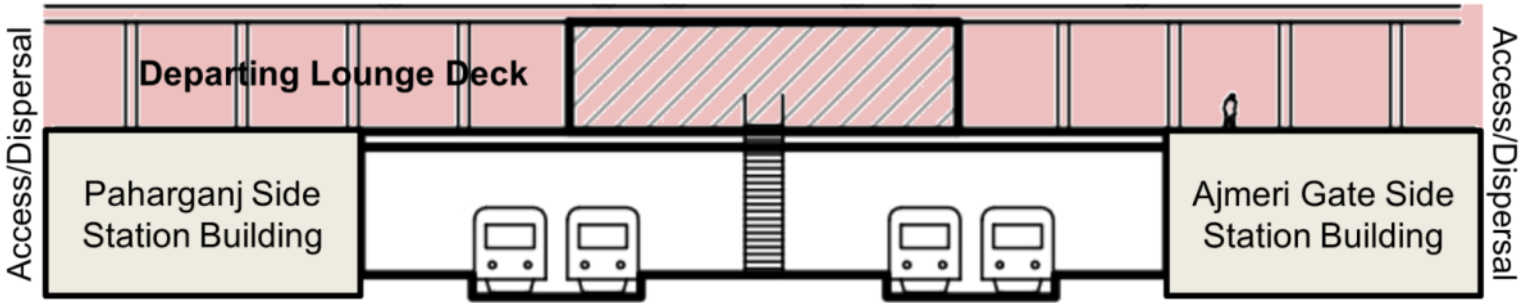


Vertical Circulation to Connect Ground with Deck Level

FAR Calculations:

Existing FAR of Station = 0.2
New FAR = 0.44
Permissible FAR = 1.0

Available access FAR can be utilized in for creating deck.



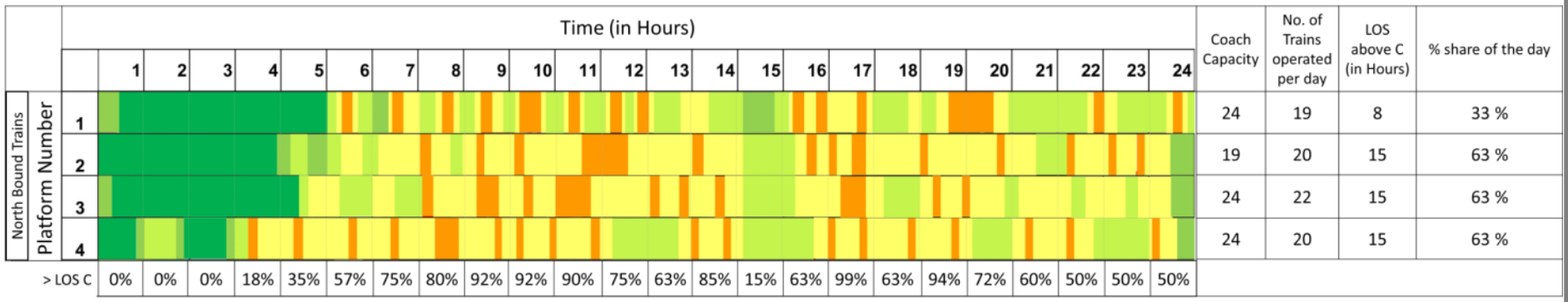
Deck's Conceptual Section with Vertical Movement at Island Platform

ALTERNATE STRATEGIES

STRATEGY 2 – CROWD MANAGEMENT (Short Term)

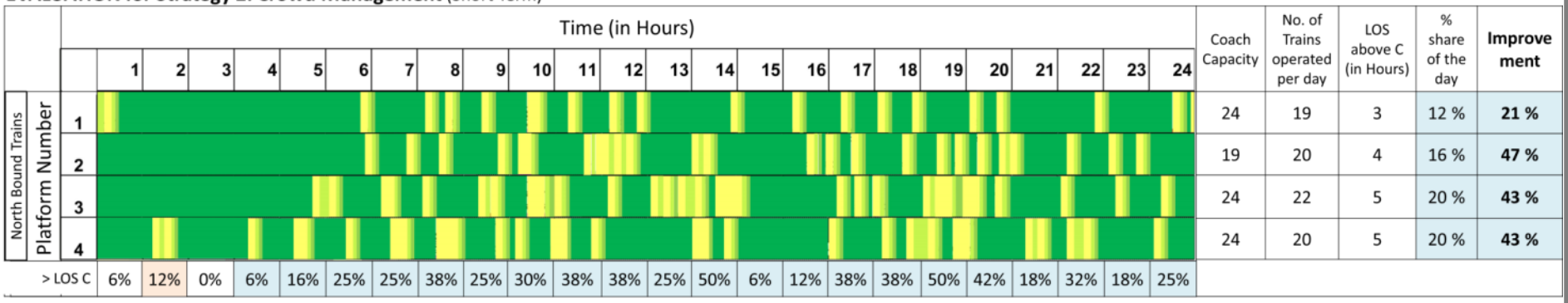
Evaluation:

EXISTING Platform-wise LOS



Coach Capacity	No. of Trains operated per day	LOS above C (in Hours)	% share of the day
24	19	8	33 %
19	20	15	63 %
24	22	15	63 %
24	20	15	63 %

EVALUATION for Strategy 2: Crowd Management (Short Term)



Coach Capacity	No. of Trains operated per day	LOS above C (in Hours)	% share of the day	Improvement
24	19	3	12 %	**21 %**
19	20	4	16 %	**47 %**
24	22	5	20 %	**43 %**
24	20	5	20 %	**43 %**

- **65 – 70 % Improvement in overall LOS**

- INTRODUCTION
- METHODOLOGY
- LITERATURE REVIEW
- DATA BASE
- STUDY AREA
- NEW DELHI RAILWAY STATION CHARACTERISTICS
- LEVEL OF SERVICE ASSESSMENT
- ALTERNATE STRATEGIES FOR STATION PRODUCTIVITY IMPROVEMENT
- **SUMMING UP**

SUMMING UP

CONCLUSIONS

I. Railway Stations are **important component** of transport system, However, there are **no benchmarks of productivity** for railway stations.

II. Railway Stations in **India carry 16,500 pax/Ha** whereas **Europe carry 74,000 pax/Ha** on an avg.

III. The existing status of station (New Delhi) show following character –

a) Dwell Time (Average)

i.	Departing Passenger (Unreserved)	: 46 minutes
ii.	Departing Passenger (Reserved)	: 37 minutes
iii.	Arriving Passenger	: 14 minutes

b) Level of Service (LOS)

i.	Platforms	: 25 – 75 % day-time LOS ≥ D
ii.	Walkway (FOB)	: D (Space – 2.1 m^2 / pax)
iii.	Staircase	: D (Space – 0.9 m^2 / pax)
iv.	Escalators	: C (Space – 1.3 m^2 / pax)

c) Performance of Side and Island Platforms

i.	Average LOS of Side Platform	: 25 – 33 % day-time LOS ≥ D
ii.	Average LOS of Island Platform	: 50 – 75 % day-time LOS ≥ D

d) Critical Time of Platforms overall LOS

i.	Morning	: LOS ≥ D at 6am – 7am
ii.	Evening	: LOS ≥ D at 5pm – 6pm

SUMMING UP

CONCLUSIONS

IV. Issues affecting Productivity

a) **Loss of efficiency** of platforms due to mixed use as passenger amenities like shops, utilities, waiting areas etc. are provided on platforms itself.

b) Absence of adequate hold-up areas for **crowd** management.

c) Island Platforms have lesser space as compare to side platform, and more roles.

d) **Luggage** is carried in very large amount by passengers (**1 bag per Person**).

e) **75% passengers** are reaching station before **20-30 min**. of their train departure time.

f) **Weak enforcement**, passengers use staircases and Platforms as resting place.

V. Alternate **Scenarios** for productivity improvements

a) **STAGGERING OF TRAIN SCHEDULE** has potential of improving performance from –

i. Platforms : 4 – 8 % Improvement in LOS
ii. Walkway (FOB) : LOS D can be lifted to LOS C for particular time Duration
iii. Staircase : LOS D can be lifted to LOS C for particular time Duration
iv. Escalators : LOS C can be maintained easily

b) **CROWD MANAGEMENT by Creating Departure Lounge Deck** can improve performance from –

i. Platforms : 65 – 70 % Improvement in LOS
ii. Walkway (FOB) : LOS D can be lifted to LOS C for most of the time in a day
iii. Staircase : LOS D can be lifted to LOS C for most of the time in a day
iv. Escalators : LOS C can be maintained easily

SUMMING UP

RECOMMENDATIONS

I. Productivity Improvements

a) **Immediate Action** : Staggering of Train Schedule

b) **Short Term** : Setting up of departure lounge deck

c) **Medium Term** : Creating directional terminal for destined trains

North Direction : Holambi Kalan Railway Station
East Direction : Anand Vihar Railway Station
South Direction : Hazrat Nizamuddin Railway Station
West Direction : Bijwasan Railway Station

➢ **Operation of only passing trains from New Delhi Railway Station**

From SPA Study, 2013:

Percentage split of passengers commuting by arriving, departing and passing trains at New Delhi Railway Station are as follows:

- Arrival Train Passengers : 26 %
- Departing Train Passengers : 27 %
- Passing Train Passengers : 47 %

Thus, as per present daily footfalls i.e. 482,800 users

- **Passing Train Users : 2,26,916 passengers (47% of existing)**

Remaining **2,55,884 (53%)** passengers using arriving & departing trains can be easily **shifted to proposed directional railway terminals** as they are under utilized.

SUMMING UP

RECOMMENDATIONS

II. **City-side transport should get focus** –

   a. **Public Transport integration**, night services should also be provided.

   b. Parking Facilities – should have special norms.

      - **Multi-level parking** is the need of major railway stations like New Delhi.

III. **Increased enforcement** for unmanaged spaces like stairs, walkways, platforms etc.

IV. **Maximum use of Air space** to achieve maximum FAR for better **convenience of user & economical use of space** by developing commercial or mixed-use development in association with the development of the station based on PPP.

THANK YOU